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DEVELOPMENT AND CLIMATE CHANGE

The **Social Dimensions** of Adaptation to Climate Change in **Bolivia**

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ECONOMICS OF ADAPTATION TO CLIMATE CHANGE

The **Social Dimensions** of Adaptation to Climate Change in **Bolivia**

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ACRONYMS AND ABBREVIATIONS

NDP	National Development Plan
PDM	Municipal Development Plan
PNCC	National Climate Change Program
POA	Annual Operating Plan

ACKNOWLEDGMENTS

The social component of the Economics of Adaptation to Climate Change (EACC) study (hereafter 'study') was developed through the joint efforts of the World Bank Social Development (SDV) and Environment Departments (ENV) and LCR, AFR, EAP, and SAR Regions of the World Bank; ESSA Technologies Ltd and the International Institute for Sustainable Development (IISD), Canada; and research institutions in Bolivia, Bangladesh, Ethiopia, Ghana, Mozambique, and Vietnam. The study was undertaken by a core team led by Robin Mearns and comprising Anne Kuriakose, Carina Bachofen, Nilufar Ahmad and Minna Kononen (all SDV). An overall synthesis report of all six country reports has been prepared and is available at www.worldbank.org/eacc. The study was designed and implemented in close collaboration with the team leader for the overall EACC study (Sergio Margulis), and Ana Bucher, Laurent Cretegny, Urvashi Narain, Kiran Pandey, Robert Schneider (all ENV) and sector consultants.

The Bolivia country study for the social component was led by Carina Bachofen, under the overall guidance of Robin Mearns, in collaboration with the EACC country team leader Ana Bucher (ENV) and country office sector liaison Ruth Llanos (LCSSO). The research partner in Bolivia was Miguel Morales.

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1. SCOPE AND METHODOLOGY OF THE STUDY

GENERAL APPROACH

The study in Bolivia was based on the concepts contained in the document *Methodology for the Social Component* (October 2008) prepared by the core team in Washington. This lists the social component objectives as: to develop a methodology for estimating the costs of adaptation strategies at the local level; to identify how public adaptation policies can benefit the most vulnerable members of society; to identify how factors such as socio-economic status, gender and poverty impact on vulnerability to climate change; and to ascertain local perceptions of the costs and benefits of climate change adaptation in different agro-ecological zones.

In the Bolivia study the methodology focused on:

- The local level, i.e., communities and municipalities;
- The poorest and most vulnerable communities and social groups;
- Participatory analysis, involving the most vulnerable sectors in the analysis of adaptation measures;
- Existing adaptive responses, to retrieve knowledge and previous experiences;
- 'Soft' and 'hard' adaptation measures;
- Bottom-up approximation, prioritizing data collection in the field;
- Triangulation of different sources of information.

STUDY PHASES

The study was conducted in four phases:

1. **Preparation:** The main objectives of the first phase were: (a) to collect qualitative, quantitative, and illustrative secondary data related to climate change and (b) to analyze previous studies undertaken in Bolivia on climate change adaptation.
2. **Sampling:** The second phase, which lasted one month, primarily consisted of constructing a climate vulnerability zoning pattern of the entire country to serve as a basis for identifying and selecting areas for study. Using the reasoned sampling technique, 14 municipalities were selected containing the 14 communities to be targeted by the study (the "study communities"). Chapter 4 contains a detailed explanation of the sampling procedure and the characteristics of each of the selected municipalities.
3. **Field work:** The field work was undertaken over a period of three months, consisting of three activities: (a) designing tools for field work; (b) identification, recruitment and training of researchers; and (c) information collection in the field through interviews and workshops.
4. **Reports:** The final phase involved processing and analyzing the information and drafting the Final Report.

METHODOLOGICAL APPROACH TO THE FIELD WORK

While the literature provided important references, the main source of information for the study was field work.

This involved visiting communities and homes in rural areas to organize workshops and conduct interviews locally.

Our field work generated two types of information:

1. *Basic information*: mainly descriptions of livelihood strategies, socio-economic conditions, vulnerability to climate change, etc.
2. *Information on adaptation measures*: Identification of the views held by the campesinos and others with regard to adaptation measures, and participatory construction of scenarios and strategies to address climate change.

The basic information was generated through surveys, interviews and workshops, employing the traditional PRA (Participatory Rural Appraisal) research technique.

Information on adaptation measures required the development of specific tools based on Participatory Analysis methodology. This methodology, developed for work in rural communities, is deployed to help local people to produce consensual and hierarchical responses to new problems or hypothetical situations. In our specific case, the methodology was used for participatory identification of climate scenarios and to formulate adaptation strategies to cope with climate change.

The methodological approach for identifying adaptation measures was as follows:

1. *Climate scenarios*

   The field work commenced by constructing climate scenarios with the assistance of the population, raising questions such as: "What will climate change be in our community?"

   Efforts were also made, for example, to get the communities to identify the climate trends observed over the last 20 to 30 years (e.g.: "How has the climate changed since our childhood?"). This led to the analysis of specific indicators.

   The communities were informed of the results of studies and climate models for the whole country and the particular region.

   With this information, communities were in a better position to consider what the future climate situation might be in their areas. A number of different scenarios were analyzed and the scenario considered to be "most probable" by the community was awarded priority.

2. *Possible impacts*

   Individual communities were asked to reflect on the possible impacts of their prioritized climate scenario. The different ways in which the community and households would be affected by the climate scenario were thus identified. Communities also identified the livelihoods which were likely to be most vulnerable to climate change.

3. *Adaptation measures*

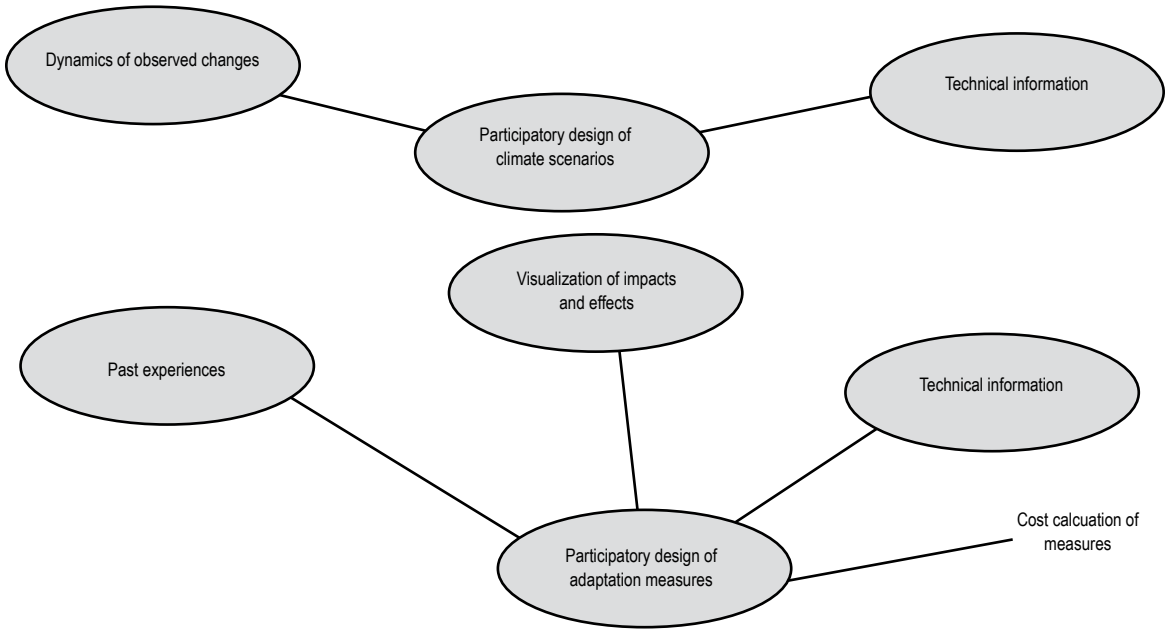
   In focus groups and community workshops the adaptation measures needed for addressing the prioritized scenarios were identified and analyzed. This process took the form of an initial brainstorming followed by an analysis and detailed description of each measure in order to provide a basis for subsequent cost calculations.

   Once the key measures had been identified the community proceeded to arrange them according to priority of implementation[1]. Communities based their list of priorities on a range of different criteria such as:

- **Urgency:** "Does the measure need to be effected immediately?"
- **Importance:** "Will this measure resolve our most pressing problems?"
- **Timing:** "What is the right time to implement this measure? What conditions need to be met prior to implementation?"
- **Feasibility:** "Can this measure be implemented in practice, given current availability (or not) of resources and technology?"

1 This process of prioritization of measures is common in the rural communities of Bolivia, since according to law the communities must identify and prioritize the investments of their respective municipal governments.

FIGURE 1. METHODOLOGICAL APPROACH USED FOR IDENTIFYING COMMUNITY ADAPTATION MEASURES



- **Coverage:** "How many families will benefit from the measure?"

After the adaptation measures had been prioritized, we proceeded to quantify the cost of each of them.

The above methodological approach is outlined in the following diagram:

English translations: Top left: "Dynamics of observed changes; top right, "Technical information; center, "Participatory design of climate scenarios; middle row, left to right, "Past experiences," "Visualization of impacts and effects," and "technical information;" bottom center: "Participatory design of adaptation measures." Bottom right: "Cost calcuation of measures."

INSTRUMENTS

The instruments used in the course of field work consisted of workshops, key-informant interviews, and direct observation in the municipalities studied:

ACTIVITIES UNDERTAKEN

In the course of the study we undertook the following activities:

- 14 workshops with municipal authorities. In each municipality we worked with the Mayor or City Council President and also interviewed senior municipal technical staff (e.g., the Chief Executive Officer).
- We interviewed 42 key informants. In each municipality we interviewed three informants who were well informed about municipal and/or environmental issues. These informants, all permanent residents of the municipalities, were professionals of one kind or another (e.g., teachers and technical staff) or representatives of social organizations.
- 70 families were interviewed with a view to collecting their life stories. We interviewed five families in each community. The selection of households was done randomly, the only obligatory requirement being to ensure participation in the interview by the

TABLE 1. METHODOLOGICAL INSTRUMENTS USED IN THE STUDY

Item	*Instrument*	*Aim*	*Application*
00	Guide introducing the study and containing information on climate change in Bolivia	To present the EACC study to local authorities and communities	At the beginning of each interview
01	Inventory of institutions working in the municipality	To ascertain the number and characteristics of public and private institutions working in the municipality	One enquiry form per municipality, based on secondary information
02	Quantification of municipal investments in climate change	To ascertain the amount of municipal investment over the past three years in water management or environmental schemes	One enquiry form per municipality, based on secondary information
03	Interviews with municipal authorities	To gauge the perception of the local authorities with regard to climate change in the municipality and to the possible adaptation measures to be implemented	Interview with the mayor, City Council President and / or senior official
04	Identification and description of communities in the municipality	To learn about the features of the communities in the municipality according to environmental, socio-economic production and productive criteria.	Applied in five representative communities of the municipality, based on secondary information and interviews
05	Interview guide for use with key informants	To learn the perceptions of the best- informed members of the municipality regarding climate change, livelihood strategies, and the community's vulnerability to climate change.	Three to five interviews per municipality with key informants
06	Guide to community workshop on participatory construction of adaptation measures	To organize a community workshop to identify trends in climate change, to identify climate scenarios for the future, to analyze the possible impacts of climate change, and to identify and prioritize adaptation measures	Five forms per community completed at a community workshop
07	Guide to focus group workshop on participatory construction of adaptation measures	To use focus groups to identify adaptation measures based on the prioritized scenarios	Three focus groups per community representing the three main livelihood strategies in the community.
08	Family interview guide for researching life stories	To obtain an accurate picture of families on the basis of socioeconomic criteria; to identify past family coping actions after climate-induced accidents; to ascertain the roles of family members; to discuss possible adaptation measures to be taken by families.	Five family interviews per community, involving visits to each household and interviews in the presence of the entire family.
09	Form for quantifying costs of adaptation measures	To quantify the costs (in local prices) of the adaptation measures identified by the communities	One record slip for each measure
10	Guide to drafting community report		

whole family. Each interview lasted an average of two hours.

- 45 workshops were conducted with focus groups. In each community between three to four focus groups were identified and classified according to livelihood strategies. Each focus group consisted of six to eight persons. The focus group work lasted three to four hours per group.
- 14 community workshops were organized, with participation by all the members (men and women) of the community. Each community workshop lasted an average of six hours. The workshops were useful for checking key information obtained from field work and for identifying and prioritizing adaptation measures.
- At the conclusion of the second phase of the study we organized a "national workshop" with experts from the country's different macro-regions. This provided an opportunity for discussing the main findings of the study and for analyzing the climate scenarios and life strategies prevailing in each macro-region.

PARTICIPATING INSTITUTIONS

The collection of field information was undertaken by private development institutions selected for their known expertise in research studies, project execution, and on-the-ground knowledge of the municipalities. Each institution provided a team of four researchers

who were to be responsible for undertaking all the respective tasks. The researchers received training in La Paz on the implementation of all the tools contained in the methodology.

The institutions described in Table 1 were responsible for the field work.

SCOPE AND LIMITATIONS OF THE METHODOLOGY

Given that this was a qualitative study aimed at ascertaining the perception of the population on a new topic, the methodology naturally reflected the scope and limitations germane to this type of study. The main limitations were:

Available information: The adaptation measures identified were the result of the technical information available to the communities and represented their views at that particular moment in time. These views might have been erroneous or biased, but they nevertheless were accepted as forming the basis of all the decisions made by the communities.

Uncertain climate data: The scenarios of the models are contradictory and vague, and no certainties exist regarding the magnitude of future climate change. Our methodology was therefore based on projections which reflected the trends in climate change as observed by the communities. This approach obviously had limitations but was deemed to be the most reliable at the time.

Sample size: The most important limitation of the study was without doubt the sample size. We consider that the sample used was too small to adequately represent the situation on a broader nationwide basis. The obvious outcome is that it is not possible to undertake statistical analysis with the results of the study, and much less to project the results onto a larger canvas. The numerical data obtained from the study can only be used as reference material.

Sample selection: The sample was selected by considering vulnerability to climate change criteria. For this reason we chose precisely the most vulnerable municipalities. This means that adaptation measures and associated costs do not represent the situation of the "average" municipalities. It is probable that in a municipality which is not as vulnerable as those studied the costs associated with adaptation measures could be lower.

Community level: The methodology was applied at the individual community level and the measures identified

TABLE 2. PARTICIPATING INSTITUTIONS

Institution	*Study Municipalities*	*Macro-region*
Tarija ACLO Foundation	El Puente (Tarija)	Valleys
Chuquisaca ACLO Foundation	Tarvita (Chuquisaca)	Valleys
Potosi ACLO Foundation	Vitichi (Potosí)	Valleys
Cordillera CIPCA (Centre for Research and Campesino Development)	Charagua (Santa Cruz)	Chaco
	Villa Vaca Guzman (Chuquisaca)	Chaco
Beni CIPCA	San Ignacio de Moxos (Beni)	Plains
IPHAE (Institute for Man, Agriculture and Ecology)	San Pedro (Pando)	Plains
CEPAC (Rural Agricultural Promotion Centre)	Yapacani (Santa Cruz)	Plains
CIAT (Center for Tropical Agronomy Research)	Saipina (Santa Cruz)	Plains
ISA Bolivia (Bolivia Socio-Environmental Institute)	Carangas Curawara (Oruro)	Altiplano
	Porco (Potosí)	Altiplano
	Sicaya (Cochabamba)	Valleys
SEMTA (Multiple Services for Appropriate Technologies)	Pucarani (La Paz)	Altiplano
	Calacoto (La Paz)	Altiplano

at this level effectively constituted that community's adaptation measures and strategies. "Multicommunity" adaptation measures were not identified. This was, for example, the case of river or catchment basin (cuenca) management. This was analyzed in the communities as one of the few options for improving the flow recovery of catchment basins and rivers, to inhibit erosion and reduce the effects of flooding. But such measures were not prioritized because they required the agreement of all the communities occupying the respective basin. In cost terms this limitation is important because the costs involved in multicommunity adaptation measures tend to be significantly higher than for those involving only individual communities.

Private level: No measures were identified for which the state should take responsibility for adaptation measures. Communities reflected on how to adapt to the measures themselves and not how the state should intervene. As a result, we were unable to identify any investments designed to improve government services, such as providing timely and adequate humanitarian assistance in the event of flooding or drought, or the provision of better health care or education. Communities also raised the need to switch their crops and livestock to varieties and breeds that would adapt better to climate change but failed to identify any measures or investments that the state should undertake to develop the required types of genetic material for the communities.

Focus on adaptation: Given that the focus of the study was to identify measures that would enable families to continue living in their communities, the communities did not consider the idea of temporary or permanent migration as a viable adaptation measure. In practice it is likely that migration will continue to grow apace, and it is incumbent on the state to consider the investments needed to track and provide support to such migrants.

Short-term horizon: The study initially sought to design adaptation measures for the next 50 years, but in the field tests it was found that this was a very distant horizon due to the lack of accurate climate scenarios and the substantial and numerous uncertainties impacting the life of rural communities. People living in the communities regarded a period of 10 to 15 years as "long term." To ensure achievable and concrete measures of the right magnitude, it was therefore decided to limit the time horizon to 15 years.

Rural areas: Priority was given to the study of municipalities in rural areas where the population is more vulnerable. Urban areas are also subject to climate change, but the problems involved in addressing climate adaptation in such areas are bound to be different. This is a challenge that needs to be addressed by a specific study employing a different methodology.

2. BACKGROUND ON BOLIVIA

THE GENERAL CONTEXT

Location

Bolivia is a landlocked country located in the heart of South America. It borders on Brazil, Peru, Argentina, Chile, and Paraguay.s

Demography

Bolivia currently has about 10.4 million inhabitants, with an annual growth rate of 2.7 percent. The country covers a large land area, with a population density of only 10 people per square kilometer, the lowest in the entire continent. Around 40 percent of the population lives in rural areas. The largest city is Santa Cruz, with a population of just over 1.7 million.

Economy

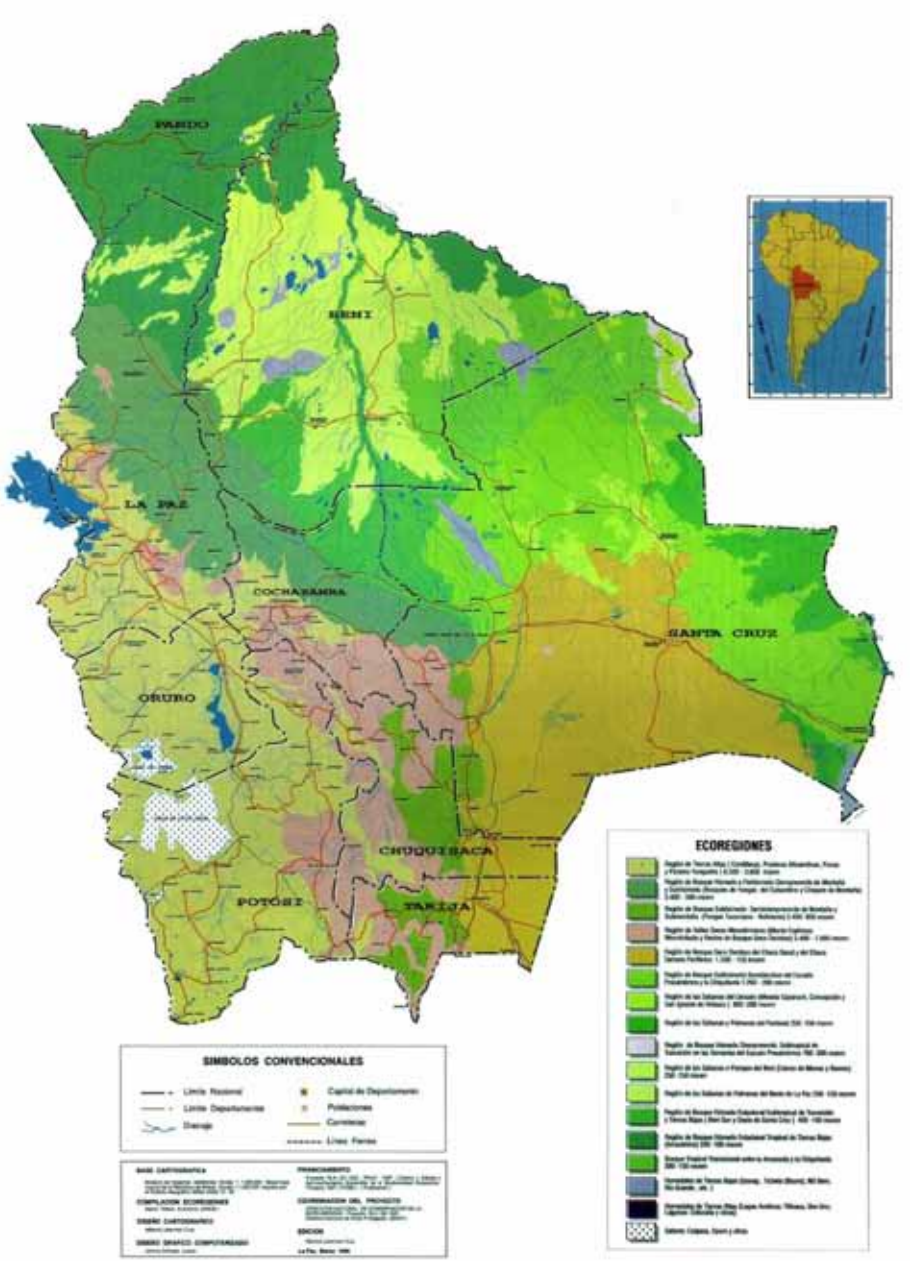
The annual per capita income (GDP per capita) is US$1,363 (2007) which makes Bolivia the poorest country in Latin America. According to the last population census (2001), some two thirds of the population live in poverty, and the remaining third in 'extreme' poverty.

TABLE 3. BOLIVIA: KEY ECONOMIC INDICATORS, 2007

Indicator	*Unit*	*2007*
Gross Domestic Product (Current prices)	US$ million	13,395
Growth (1)	Percentage	4.56
Accumulated Inflation	Percentage	11.73
Exchange Rate	National currency to US$	7.90
Average Annual Fluctuation in Exchange Rate	Percentage	(4.28)
Unemployment	Percentage	5.18
Current Account Balance	US$ million	1,758
External Debt	US$ million	2,183
Gross Fixed Capital Formation	US$ million	2,162
Private Consumption	US$ million	8,469
Public Consumption	US$ million	1,883
Per capita GDP	US$	1,363

Sources: Latin American Integration Association; International Monetary Fund; National Institute of Statistics; Bolivian Central Bank.

FIGURE 2. BOLIVIA: MAP SHOWING ECO-REGIONS



Bolivia has a limited domestic market with low purchasing power and a small industrial sector, with domestic demand largely met by imports. The economy is based on the export of minerals and hydrocarbons, activities generating over 50 percent of national revenue but employing few people. Agricultural productivity is very low, with average yields of traditional crops 50 percent lower than those in the rest of Latin America.

According to National Institute of Statistics, data labor productivity in the agricultural sector is six times lower than in the rest of the country's economy.

TABLE 4. 1981–2000 AVERAGE YIELDS (TONS PER HECTARE)

	Wheat	*Corn*	*Potato*	*Quinoa*
Bolivia	0.8	1.7	4.9	0.5
South America	1.9	2.4	2.12	0.6
France	6.3	7.4	33.7	0

Source: FAO 2002

Diversity

Bolivia possesses the largest "indigenous" population of all South America, consisting of 36 ethnic groups, settled mainly in rural areas. These groups reflect the country's rich cultural diversity.[2]

Bolivia is also characterized by wide-ranging agro-ecological diversity with territory stretching from the Andes to the Amazon jungle. The country contains at least 16 major eco-regions that range in height from 300 to 6500 meters above sea level and which possess a broad range of vegetation (forests, savannas, steppes, scrubland etc) and climates (varying from cold and dry to humid and warm).

Since pre-colonial times each eco-region has been inhabited by indigenous peoples, mainly small farmers and livestock raisers but also hunters and fishermen, all of whom have developed a wide range of long term sustainable life strategies in harmony with their environment.

Population growth and climate change in recent years have however brought into question this sustainability. New generations now find it difficult to eke out a living in their ancestral lands and are experiencing profound crises owing to the weakened capacity of the ecosystem. It is clear that important changes will need to be made to all the production systems, which obviously will involve changes in the rural population's livelihood strategies.

Climate Change

Climate change is already apparent throughout most of the country. According to the National Climate Change Program (PNCC), all the Andean glaciers, a source of drinking water and energy for some major cities like La Paz and El Alto (which are over 40 percent dependent on these sources), are experiencing rapid meltdown.

Climate models developed for this study (water component) show that average temperatures are on the increase. The rainfall pattern has undergone changes, with the rainy season getting shorter but stormier.

As a result, the Altiplano (high plateau), the inter-Andean valleys, and the Chaco, inhabited by three-quarters of Bolivia's population, are experiencing a rapid process of desertification,[3] with areas of desert becoming larger and rivers and catchment areas drying up.

The country as a whole is highly susceptible to drought, since only 15 percent of all agricultural land is irrigated, with the remainder depending on rainfall—which in most parts of the country is only seasonal (four months a year).

The Amazon region of Bolivia is also experiencing a higher incidence of drought as well as increased frequency and intensity of flooding during the rainy season.

Institutional Status

Bolivia has a democratic government. The current President is Evo Morales, a representative of the campesinos and 'native' indigenous peoples. Morales was reelected in December 2009 with a majority of 65 percent, the largest in the country's history.

During his first term, President Morales oversaw the drafting and adoption of a new State Political Constitution, aimed at initiating a process of broad social and political inclusion of indigenous peoples and campesinos.

2 The exact number of indigenous inhabitants in Bolivia is not known. However the 2001 Census showed that around 40 percent of the population communicate in a language other than Spanish. This has to be treated with some caution since the language spoken does not necessarily imply that the speaker belongs to a particular ethnic group, as in the case of indigenous people who live in cities and communicate with one another in Spanish.

3 PNCC: Climate Change in Bolivia, page 83.

The Morales government also significantly revamped Bolivia's foreign policy. In the environmental area the new policy has embraced the concepts of climate debt that cast responsibility for global warming on industrialized countries. As a result, the Bolivian government calls for more stringent action to address the causes and effects of this problem, including efforts to formulate a binding multilateral instrument.

3. THE INSTITUTIONAL FRAMEWORK

STRUCTURE OF GOVERNMENT

With the approval of the new Constitution of the State of Bolivia, the overall structure of the state is organized as follows: central government, nine departmental governments (with the right to autonomy) and 327 autonomous municipalities. The Constitution also provides for indigenous and regional autonomous areas (*autonomies*) within departmental boundaries. Under the constitution, each level of self-government has the same hierarchical structure and is entitled to take decisions independently of any government.

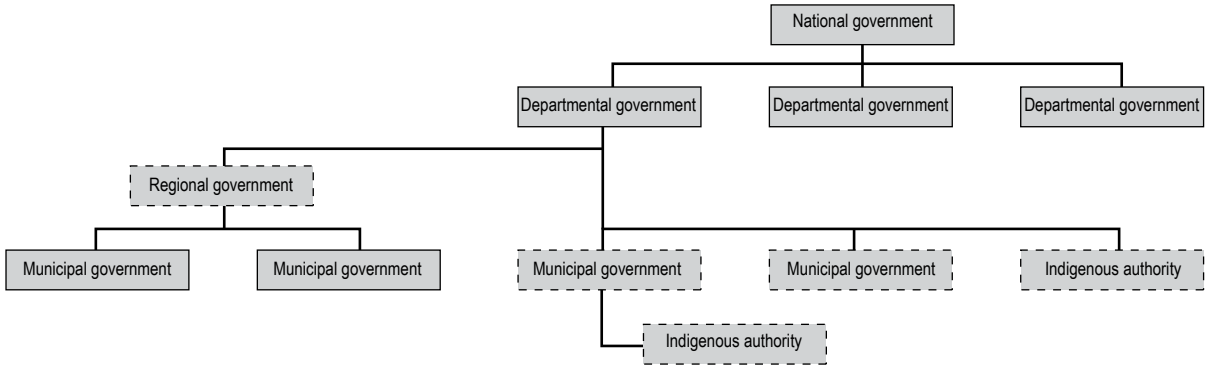
A schematic representation of the new state structure can be seen in the chart below:

POWERS OF THE DIFFERENT LEVELS OF GOVERNMENT

The recently adopted Constitution sets out the responsibilities of the different levels of government.

The Central Level possesses normative, regulatory, and executive powers to deal with biodiversity and the environment. It has the power to define overall policies and to implement programs and projects throughout the country. At the same time, the Constitution states that a number of responsibilities in these areas are to be exercised concurrently and shared with the autonomous

FIGURE 3. BOLIVIA: STRUCTURE OF THE STATE



[The lines in this graph represent connectivity not dependency].

territorial entities, i.e., the departmental, municipal and autonomous indigenous governments.

Adaptation actions with regard to climate change are defined at the central and sub-national levels within their respective jurisdictions.

THE CENTRAL STATE LEVEL

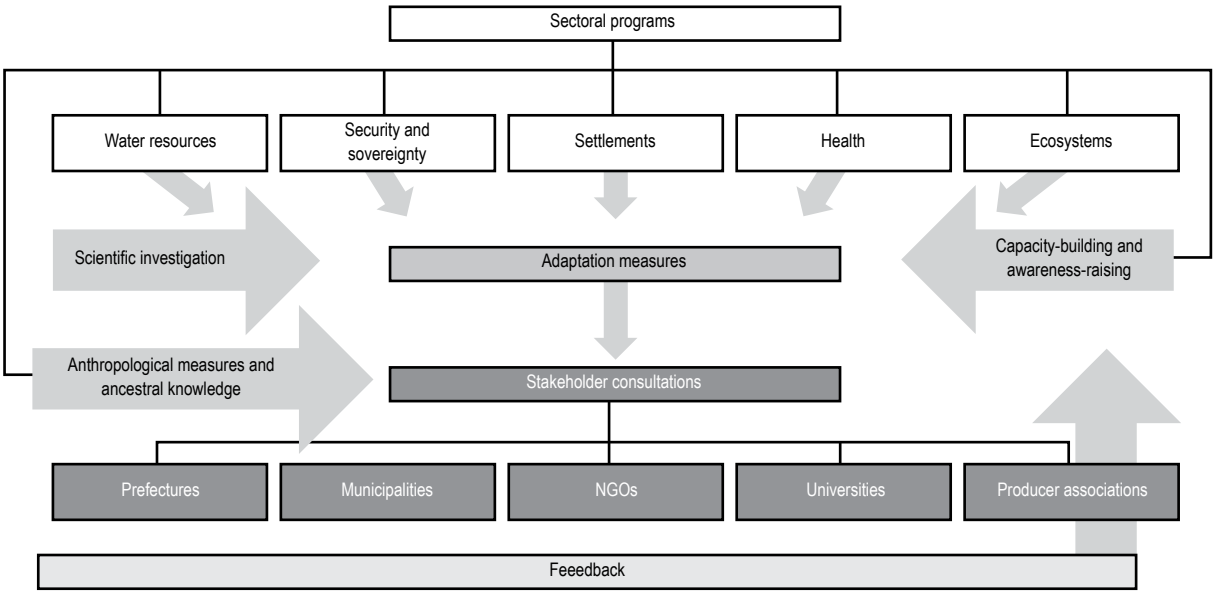
According to DS No. 29894 of February 7, 2009, the current organizational structure of what is now called the "Plurinational State of Bolivia" makes the Ministry of Foreign Affairs the entity responsible, jointly with other relevant bodies, for defending and protecting the natural resources of the state, including water resources.

Meanwhile, the Ministry of Development Planning is charged with formulating and presenting policies for science, technology, innovation, and the enhancement of local knowledge, in cooperation with the autonomous and decentralized territorial entities.

The formulation of national climate change policy is the responsibility of the Ministry of Environment and Water Resources which, through the Vice-Ministry of the Environment, Biodiversity and Climate Change, aims to promote and implement policies, legislation, plans, programs, and projects related to climate change. Jointly with other government entities and departmental governments, the Vice-Ministry is also responsible for developing the National Climate Change Program (PNCC), tasked with formulating and implementing measures for adaptation to, and mitigation of, climate change, and for monitoring the international environmental and climate change agenda.

The PNCC has formulated the National Mechanism for Adaptation to Climate Change, "which is essentially in line with the National Development Plan (NDP) and consists of a long-term strategy aimed at establishing the actions and results expected of it as a tool for formulating a structured response to global warming through adaptation."

FIGURE 4. STRUCTURE OF THE NATIONAL MECHANISM FOR ADAPTATION TO CLIMATE CHANGE



Source: PNCC, 2007

The mechanism is basically a set of adaptation programs to deal with water resources, food security and sovereignty, human settlements and irrigation management, health, ecosystems, research and training. It involves practitioners from both the public and private sectors operating within an institutional framework, as illustrated in Figure 4:

THE DEPARTMENTAL LEVEL

The prefectures (or departmental governments) are at present engaged in a re-structuring process in preparation for assuming the responsibilities assigned to them under the new Constitution. Within this context local prefectures are required to establish a Departmental Service or Division responsible, inter alia, for preparing and implementing departmental land use and environmental protection policies in line with national policy. This entity will probably be charged with leading on climate change policies in Bolivia´s departments.

Prefectural investments are governed by the Departmental Development Plan, which is drawn up with the participation of citizens and institutions.

MUNICIPALITIES

At the local level, municipal governments are responsible for preparing and implementing planning policies, environmental protection, and promotion of human development within their territorial areas. The design and implementation of policies and projects for adaptation to climate change are required to be consistent with national and departmental policies.

The formulation of policies, projects, and budgets by local governments embraces the concept of "'participatory planning." This mechanism is intended to make it possible for all citizens residing in a municipality to participate in the design of the Municipal Development Plan (PDM) and Annual Operating Plan (POA), both of which govern all investments at the municipal level. In each community the neighborhood council assembles residents once a year (in the case of the POA) and once every five years (in the case of PDM) to decide upon and prioritize the investments to be undertaken by a municipal government in its particular territory. According to law all municipal disbursements must be registered in the PDM, with the details available for public scrutiny.

The communities themselves are responsible for defining the type of investments to be undertaken by the municipal government, meaning that efforts to mobilize local resources for climate adaptation will necessarily involve convincing both the mayor and the wider community of the need for the relevant initiatives to be financed.

THE INDIGENOUS CAMPESINO *AUTONOMIES*

The Constitution provides that the indigenous campesino autonomous areas (*autonomies*) shall, within their territorial jurisdiction, possess exclusive responsibility for their own land and environmental management and promotion of agricultural development (Art. 304). These autonomous areas are not in operation to date, but on December 6, 2009, a total of 11 municipalities chose to transfer their "municipal" autonomous status to that of "original indigenous" *autonomies* and were to (in April 2010) elect transitional authorities in advance of the approval and entry into force of the new territorial entities.

REGIONAL *AUTONOMIES*

The Constitution also establishes the possibility of creating autonomous regions, to be established within departments by clustering municipal territories. Regional autonomous authorities will possess powers delegated to them by the prefectures (i.e., further decentralizing regional government). In December 2009 the province of Gran Chaco, for example, opted for regional autonomy and discussions are underway on the modalities which will govern elections for its regional authorities.

CIVIL SOCIETY

Keen participation by citizens in public investment decisions at all levels of government, particularly in the municipalities, is widespread. In the case of the regional and autonomous campesino indigenous areas, a good chance exists of them also opting for public participation in the planning processes along the same lines as the municipalities.

This implies that for the state to invest in climate change adaptation measures, citizens must be in a position to prioritize both their requirements and projects.

Civil society institutions (NGOs and research centers) have to date worked in isolation on climate change issues. This work has mainly been in the form of studies, knowledge of which has failed to filter down to the relevant interested individuals and institutions.

Notwithstanding the above, social organizations are convinced that that they are bearers of a rich ancestral experience of adaptation to climate change and argue that this experience should be put at the service of the state and NGOs.

The Bolivian Platform for Climate Change, bringing together some fifty institutions (NGOs) and social organizations, was established in February 2009.

4. THE ZONING OF THE COUNTRY IN TERMS OF VULNERABILITY TO CLIMATE CHANGE

THE MACRO-REGIONS

In view of its socio-agrobiological characteristics Bolivia can be divided into four separate macro-regions:

- *Highlands*: At a height of over 3,500 meters above sea level, the highlands the (high plateau or "Altiplano" and the Andes mountain chain) contain municipalities such as La Paz, Oruro, Potosí, and Cochabamba. The climate is generally cold and dry. This macro-region can be further divided into two sub-regions: the northern and southern regions, with the former subject to the highest humidity.
- *Valleys*: Located in the foothills of the eastern mountains, the height of the inter-Andean valleys ranges from 1,000 to 3,500 meters above sea level. The valleys fall within the departments of La Paz, Cochabamba, Potosí, Chuquisaca, Tarija, and Santa Cruz. The climate is temperate. Again, this area can be divided into two regions: the 'dry' valleys and the more humid Yungas (including the Yungas of La Paz and the Chaparé de Cochabamba).
- *The Chaco*: Located in the south east, this area—with a hot, dry climate—is less thanr 1,000 meters above sea level and contains the departments of Tarija, Chuquisaca, and Santa Cruz.
- *The plains (llanos)*: In the northeast, lying at under 1,000 meters height and with a warm, humid climate, contain the departments of Santa Cruz, Beni, Pando, and parts of La Paz and Cochabamba departments.

Each municipality can be classified according to the macro-region in which it is located, as detailed in the map below.

Population by Macro-regions

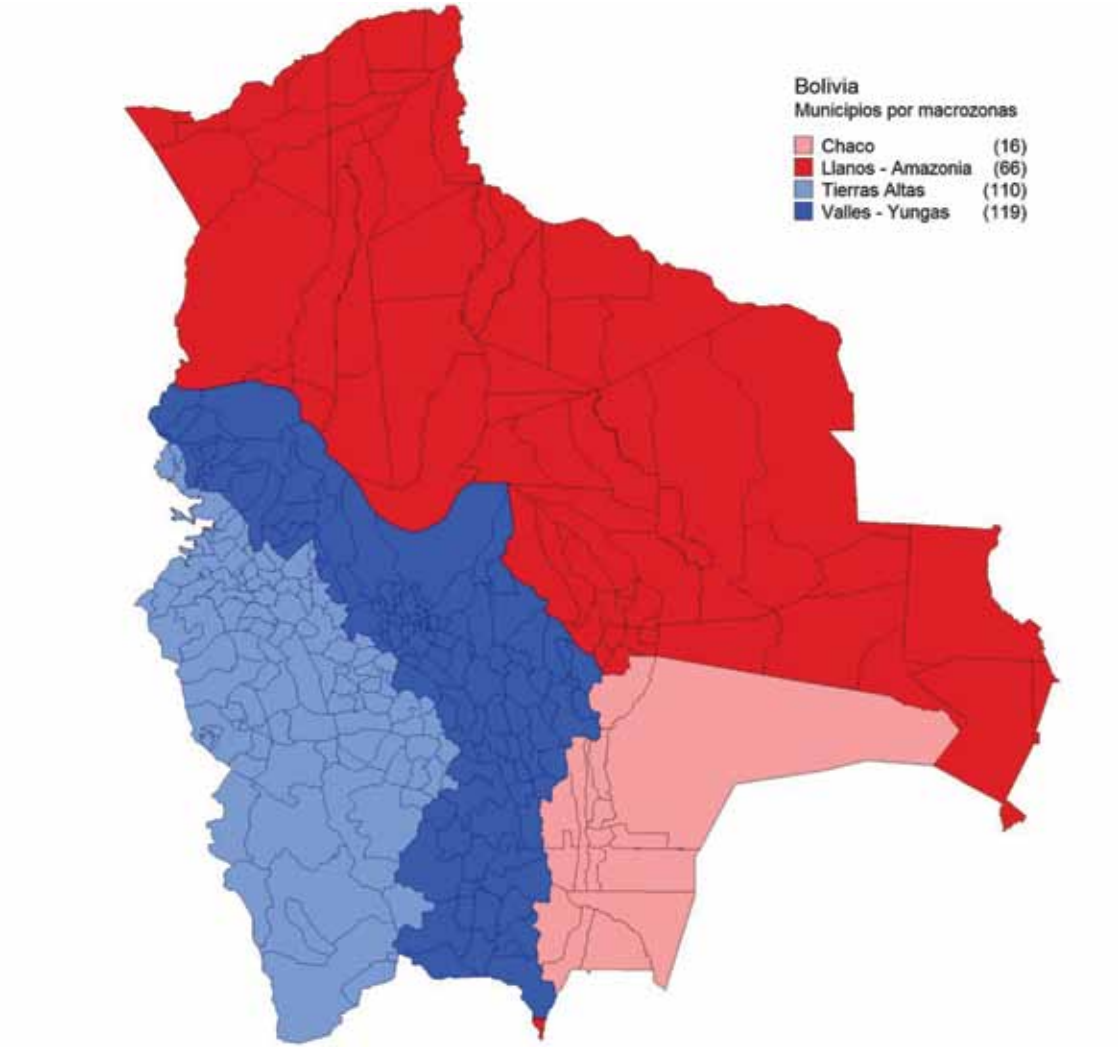
According to the 2001 Population Census, the present population in the municipalities of each macro-region is as follows:

The Valleys Region contains 42 percent of the total population, followed by the Plains Region with 29 percent. The 2001 Census also indicates that 62 percent of Bolivia's population is urban (living in towns of over 2,000 inhabitants). The same proportion is maintained in all macro-regions, except in the Plains Region, where three quarters of the population is urban.

Altitude

One of the prominent features of Bolivia is the enormous variation of altitude. The following chart compares the different altitudes above sea level of the capitals of each municipality per macro-region. It is clear that Bolivia´s four regions differ in terms of average altitude. It is also worth noting that the valleys, at an average height of 2,500 meters, present significant variations in altitude in view of their special topography, whereas the Plains Region is more uniformly flat.

FIGURE 5. MUNICIPALITIES ACCORDING TO MACRO-REGION



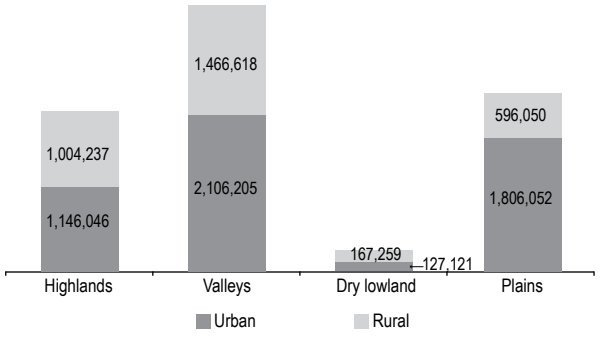
Note: Chaco = dry lowland, Llanos Amazonia = Amazonia plains, Tierras altas = highlands, Valles Yungas = Yungas valleys.

TABLE 5. BOLIVIA 2001: POPULATION BY MACRO-REGIONS

	Urban	*Rural*	*Total*	*Percent*
Altiplano	1,146,046	1,004,237	2,150,283	26
Valleys	2,106,205	1,466,618	3,572,823	42
Chaco	127,121	167,259	294,380	3
Plains	1,806,052	596,050	2,402,102	29
All regions	5,185,424	3,234,164	8,419,588	100
Percent	62	38	100	

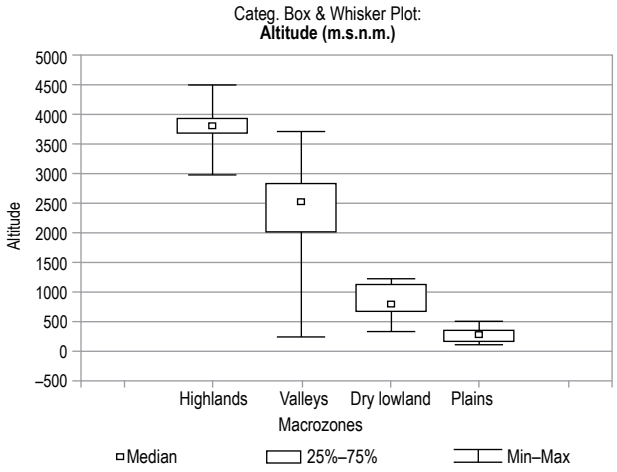
Source: Authors

FIGURE 6. BOLIVIA 2001: POPULATION BY URBAN-RURAL MACRO-REGION



Source: Authors

FIGURE 7. REGIONAL VARIATIONS IN ALTITUDE



Rainfall

The following chart (by macro-region) shows the average annual rainfall recorded (or calculated from isohyets curves) in the capital of each municipality. The municipalities in the Altiplano have the lowest rainfall levels (average 450 mm), whereas in the Plains rainfall exceeds 1,000 mm.

FIGURE 8. REGIONAL VARIATIONS IN ANNUAL PRECIPATION

Average Temperature

The following table, derived from data observed or calculated from isothermal curves, shows the mean annual temperature in the capital of each municipality. Marked differences exist between the four

FIGURE 9. REGIONAL VARIATIONS IN TEMPERATURE

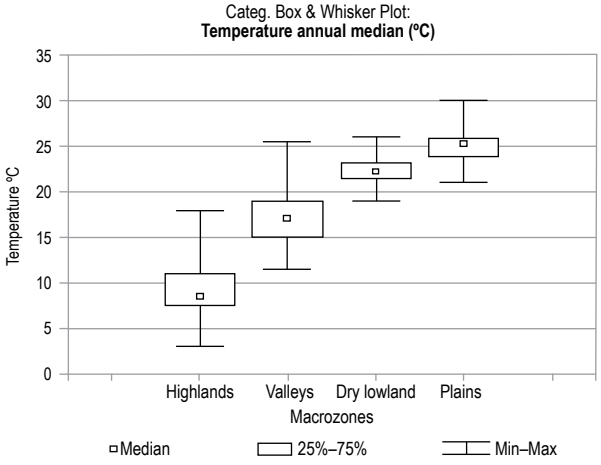


FIGURE 10. DROUGHT RISK

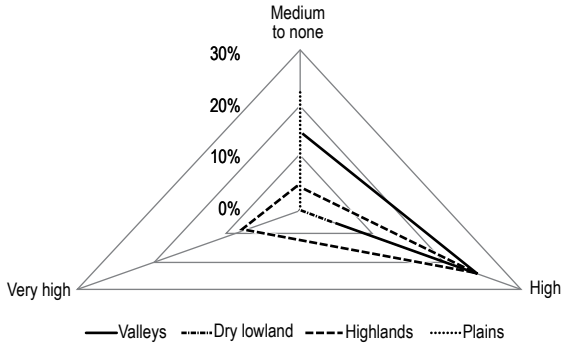


TABLE 6. DROUGHT RISK, BY MUNICIPALITIES AND MACRO-REGION

	Drought Risk			
	Zero to average	*High*	*Very high*	*Total municipalities*
Valleys	14%	24%	0%	38%
Chaco	1%	4%	0%	5%
Altiplano	5%	23%	8%	35%
Plains	21%	0%	0%	21%
Total Municipalities	41%	51%	8%	100%

macro-regions. Whereas the average annual temperature is lowest in the Altiplano and highest in the Plains, temperatures vary significantly within each macro-region.

Eight percent of Bolivia´s municipalities run a "very high" risk of drought. These are all located in the Altiplano. 51 percent, mainly municipalities in the Valleys and Altiplano, are at "high risk.". 80 percent of the Chaco municipalities are at "high risk" and those in the Plains run "low" or "zero" risk of drought.

Flood Risk

Flood risk figures have been prepared by WFP, based on data obtained from the municipalities over recent years. The table below compares flood risks for the macro-regions.

TABLE 7. RISK OF FLOODS IN MACRO-REGIONS

	Flood Risk			
	Zero to Average	*High*	*Very High*	*Total Municipalities*
Valleys	37%	1%	0%	38%
Chaco	5%	0%	0%	5%
Altiplano	29%	4%	3%	35%
Plains	6%	6%	10%	21%
Total Municipalities	77%	10%	13%	100%

The above table shows that 13 percent of the municipalities run "very high" flood risks. Most of these are found in the Plains region. No municipalities in the Chaco or the Valleys are exposed to "very high" risk of flooding.

Human Development Indicators

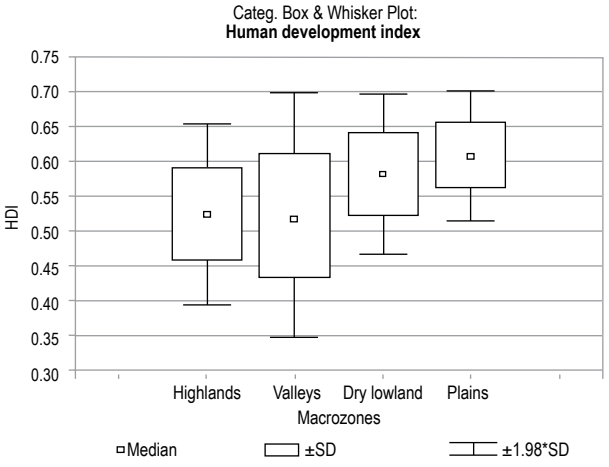
The following tables are based on HDI data compiled for 2001 by UNDP. 25% of municipalities with the lowest HDI are in the first quartile (Table 8).

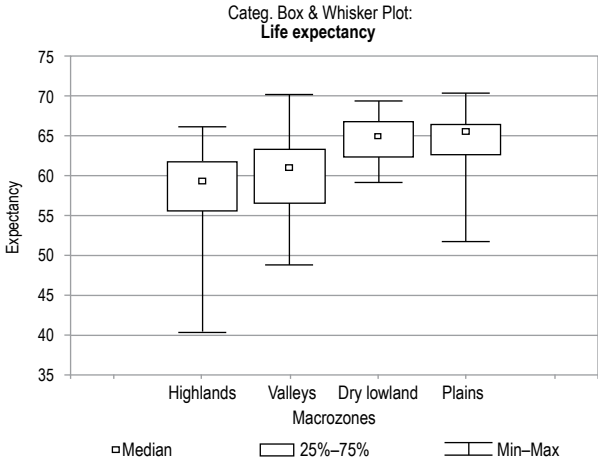
Quartile 1 (with the lowest HDI) and Quartile 2 municipalities are located virtually exclusively in the Valleys and Altiplano, indicating that poverty in Bolivia is concentrated on these macro-regions.

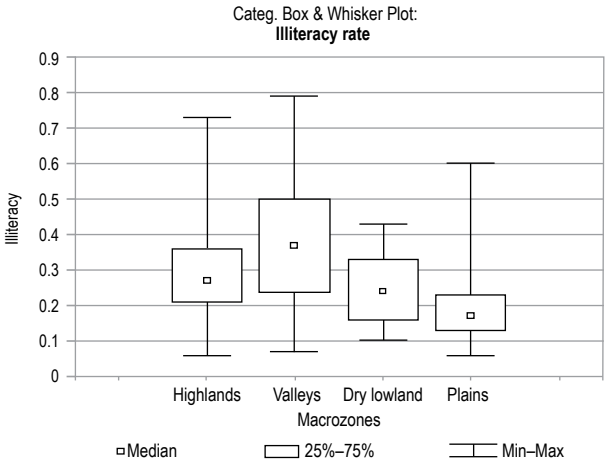
TABLE 8. HUMAN DEVELOPMENT INDEX

	Human Development Index				
	Quartile 1	*Quartile 2*	*Quartile 3*	*Quartile 4*	*Total Municipalities*
Valleys	15%	8%	8%	7%	38%
Chaco	0%	1%	1%	2%	5%
Altiplano	10%	13%	9%	3%	35%
Plains	0%	3%	6%	13%	22%
Total Municipalities	25%	25%	25%	25%	100%

FIGURE 11. HUMAN DEVELOPMENT INDICATORS







Illiteracy rate (left chart). The diagram indicates that the highest levels of illiteracy (2001 data) exist in the Valleys, followed by the Altiplano and Chaco.

Life expectancy at birth (upper right). While this indicator reveals a more homogeneous situation throughout the country, the lowest levels of life expectancy at birth are nevertheless in the Altiplano and Valleys.

Food Vulnerability

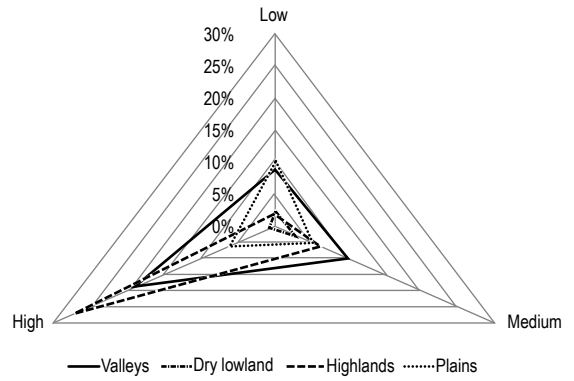
The Food Vulnerability Map published by the WFP provided the basis for the following table (table 9).

Figure 12 shows that 53 percent of Bolivia´s municipalities present a high level of food vulnerability. This is particularly the case of municipalities in the Altiplano and Valleys.

TABLE 9. FOOD VULNERABILITY, BY MACRO-REGIONS AND MUNICIPALITIES

	Food Vulnerability			*Total Municipalities*
	Low	*Average*	*High*	
Valleys	9%	10%	19%	38%
Chaco	2%	3%	1%	5%
Altiplano	2%	6%	27%	35%
Plains	10%	5%	6%	21%
Total Municipalities	23%	24%	53%	100%

FIGURE 12. FOOD VULNERABILITY BY MACRO-REGION

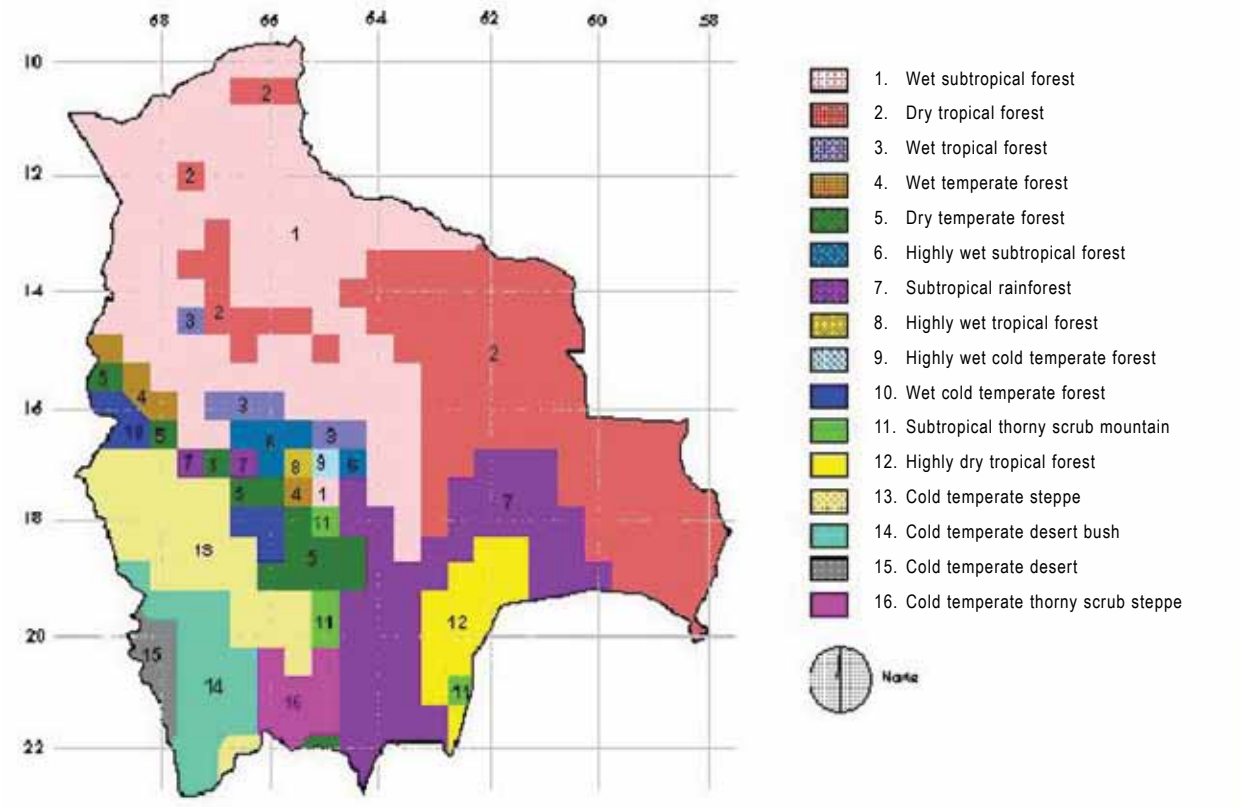


HOLDRIDGE LIFE ZONES

The PNCC has produced a national zoning map of the territory, drawing on variables closely related to climate change and using the "Holdridge model," the global bioclimatic scheme for the classification of land areas, to identify life zones.

The PNCC used the following methodology: "[...] theoretical data for temperature and precipitation was employed for each IIASA 0.5 degree geographic grid (identical to that applied for the determination of life areas according to the parameters established by Holdridge). Values were also extrapolated for certain life areas (where there were no weather stations) from SENAMHI isotherm and isohyet maps. After

FIGURE 13. BOLIVIA: LIFE ZONES IDENTIFIED BY THE PNCC



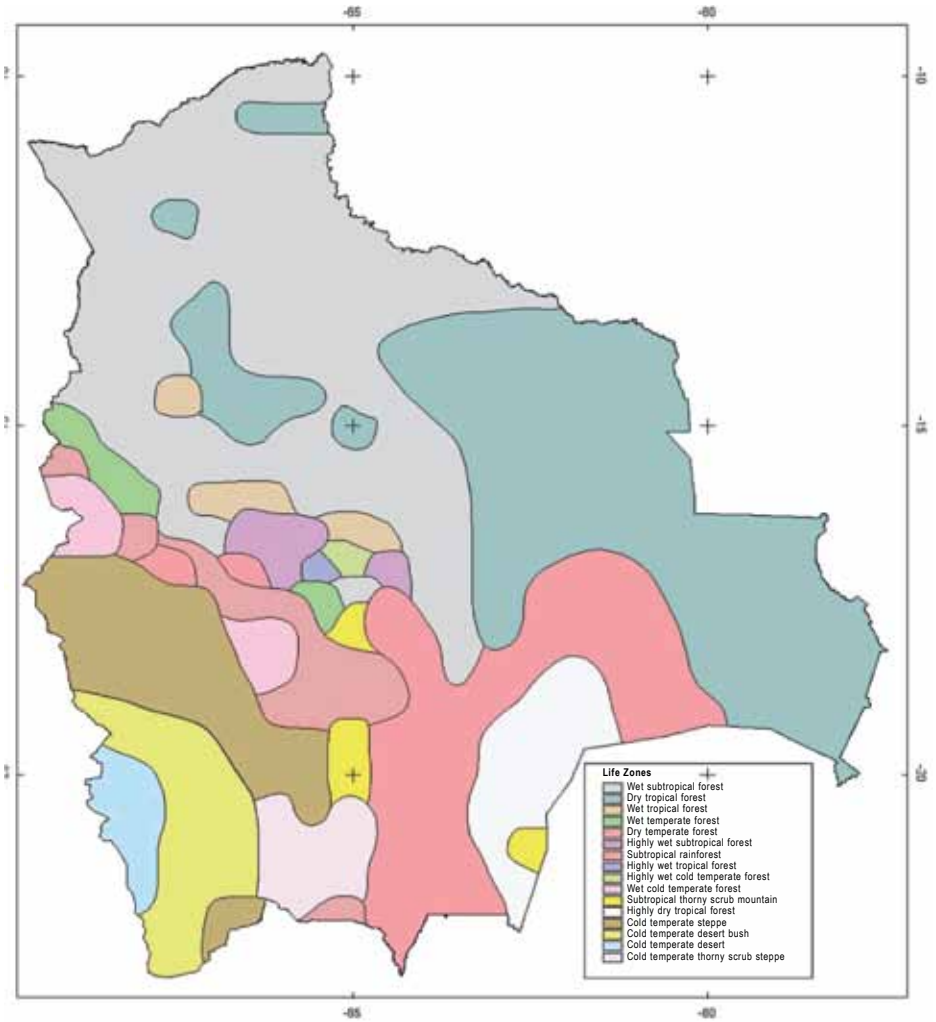
fine-tuning and updating the data, a database was constructed for inputting into the Holdridge model (1947). Given that this database included information on latitude, longitude, altitude, temperature and different climate scenarios, the model was able to classify life areas according to the various inputs. Together with the information previously described, the Holdridge model was used to determine current weather conditions in accordance with the IS92a5 climate scenario proposed by the IPCC (PNCC 2007, *Climate Change in Bolivia*. p. 33)". The results, published in 2001, are shown in Figure 13.

As can be seen in the above map, the limits defined by the model are formed by straight lines, corresponding to 0.5 degree grid squares. In 2007, the PNCC presented the map of life zones with curved boundaries, constructed by combining the Holdridge model results and the 1979 Ecological Map (See Figure 14).

SELECTION OF MUNICIPALITIES FOR THE STUDY

Urban-rural: The study team had to decide whether to concentrate efforts on rural or urban areas given that it

FIGURE 14. BOLIVIA: LIFE ZONES ADJUSTED BY PNCC



was not possible to cover both areas without undermining the accuracy of the results. Since we needed to give priority to the populations most vulnerable to climate change, it was decided to focus on Bolivia´s rural population, where the most vulnerable groups are the indigenous campesinos. Our decision to focus on the rural areas did not mean ruling out city-dwellers as also being vulnerable to climate change. It has been proven that some Bolivian cities are indeed vulnerable, especially those that depend on glaciers for water supply and irrigated agriculture to supply food, as well as the urban areas located near to large rivers that overflow during the rainy season. In this respect we believe that the urban areas should be the subject of a further study.

Sample size: In order to gain a minimal understanding of the reality of campesino existence against a background of substantial agro-ecological, cultural, and socio-economic diversity (and in view of the obvious limitations of this type of study), we decided that that the sample should cover 14 rural municipalities[4], drawn from different macro-regions and taking into account existing levels of population, vulnerability and biodiversity.

Main criterion: The main criterion for our sample selection was that of "vulnerability to climate change," and we chose to divide municipalities into three categories of vulnerability: "high," "medium," and "low." This type of indicator is complex, combining exposure criteria and vulnerability awareness to climate risks as well as the population's response capacity, education levels, and economic situation. We decided therefore that the sample should consist only of those municipalities with "high vulnerability" to climate change.

Additional criteria: We had to use a set of additional criteria in order to determine which municipalities should be sampled, given that the criteria based on location in a particular macro-region and vulnerability to climate change were not sufficient for our purposes. Other criteria included:

- *Life zones*: representing the most diverse life zones;
- *Ethnicity*: reflecting as much ethnic diversity as possible;
- *Population density*: covering municipalities with large and small populations;
- *Poverty*: includinge the poorest municipalities;
- *Drought*: including municipalities with the highest risk of drought;
- *Flooding*: including at least two municipalities at high risk from floods.

The results were as follows (see Tables 11–16 and Figure 15–16):

TABLE 10. NUMBER OF MUNICIPALITIES STUDIED, BY MACRO-REGION

Macro-region	*Number of municipalities*
Altiplano	4
Valleys	5
Chaco	2
Plains	3
Total	14

4 The budget assigned to the social area in Bolivia was not sufficient to allow a study to be made of the 14 municipalities with the result that the study was delayed by several months until additional funds were found.

TABLE 11. MUNICIPALITIES AT RISK

	Municipality	*Province*	*Department*	*Language*	*Macro-region*
1	Tarvita (Villa Orias)	Azurduy	Chuquisaca	Quechua	Valleys
2	Villa Vaca Guzman	Luis Calvo	Chuquisaca	Spanish	Chaco
3	Calacoto	Pacajes	La Paz	Aymara	Altiplano
4	Pucarani	Los Andes	La Paz	Aymara	Altiplano
5	Sicaya	Capinota	Cochabamba	Quechua	Valleys
6	Carangas Curahuara	Sajama	Oruro	Aymara-Spanish	Altiplano
7	Vitichi	Nor Chichas	Potosi	Quechua	Valleys
8	Porco	Antonio Quijarro	Potosi	Quechua-Spanish	Altiplano
9	El Puente (Tomayapo)	Mendez	Tarija	Spanish	Valleys
10	Yapacaní	Ichilo	Santa Cruz	Quechua-Spanish	Plains
11	Charagua	Cordillera	Santa Cruz	Spanish-Other	Chaco
12	Saipina	Manuel M. Gentleman	Santa Cruz	Spanish	Valleys
13	San Ignacio	Moxos	Beni	Spanish	Plains
14	San Pedro	Manuripi	Pando	Spanish	Plains

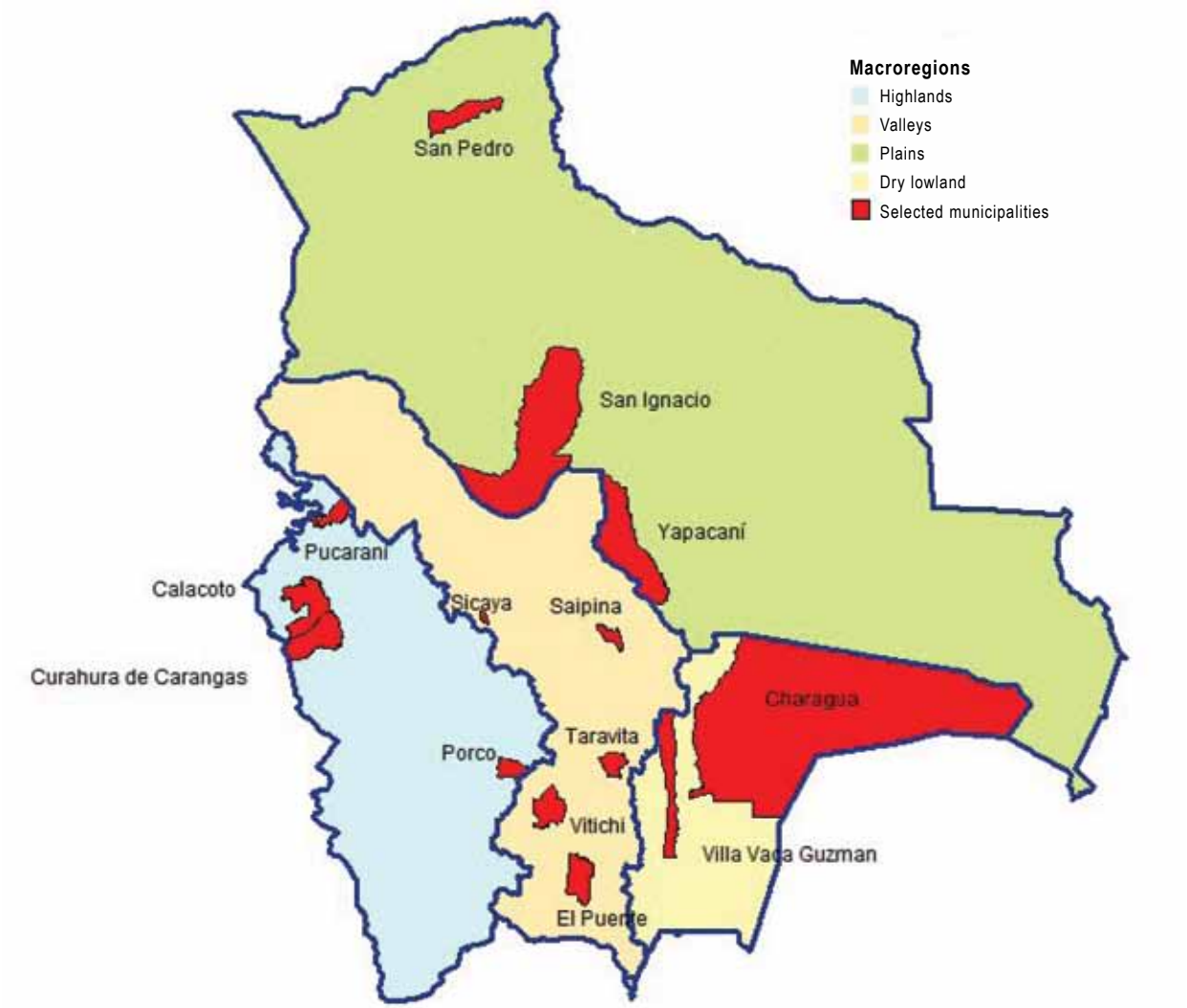
Sample by department: Chuquisaca (2 municipalities), Santa Cruz (3 municipalities), La Paz (2 municipalities), Potosi (1 municipality), Cochabamba (1 municipality), Oruro (1 municipality), Tarija (1 municipality), Beni (1 municipality), Pando (1 municipality).

TABLE 12. VULNERABILITY

	Municipality	*Vulnerability to climate change*	*Food vulnerability*	*Risk of drought*	*Flood risk*
1	Tarvita (Villa Orias)	High	High	High	Low
2	Villa Vaca Guzman	High	Average	High	Low
3	Calacoto	High	Added	High	Low
4	Pucarani	High	High	High	Average
5	Sicaya	High	High	High	Low
6	Carangas Curahuara	High	High	High	Low
7	Vitichi	High	High	High	Low
8	Porco	High	Average	High	Low
9	El Puente (Tomayapo)	High	Average	High	Average
10	Yapacaní	High	High	Medium or Low	High
11	Charagua	High	Average	High	Average
12	Saipina	High	Average	High	Low
13	San Ignacio	High	High	Medium or Low	High
14	San Pedro	High	Average	Medium or Low	High

Sample: 9 municipalities with ‘high’ food vulnerability, 11 municipalities with ‘very high’ risk of drought, 3 municipalities with ‘very high’ or ‘high’ flood risk.

FIGURE 15. MUNICIPALITIES SELECTED BY MACRO-REGION



Sample by macro-region: Valleys (5 municipalities), Altiplano (4 municipalities), Plains (3 municipalities), Chaco (2 municipalities).

FIGURE 16. MUNICIPALITIES SELECTED ACCORDING TO ALTITUDE

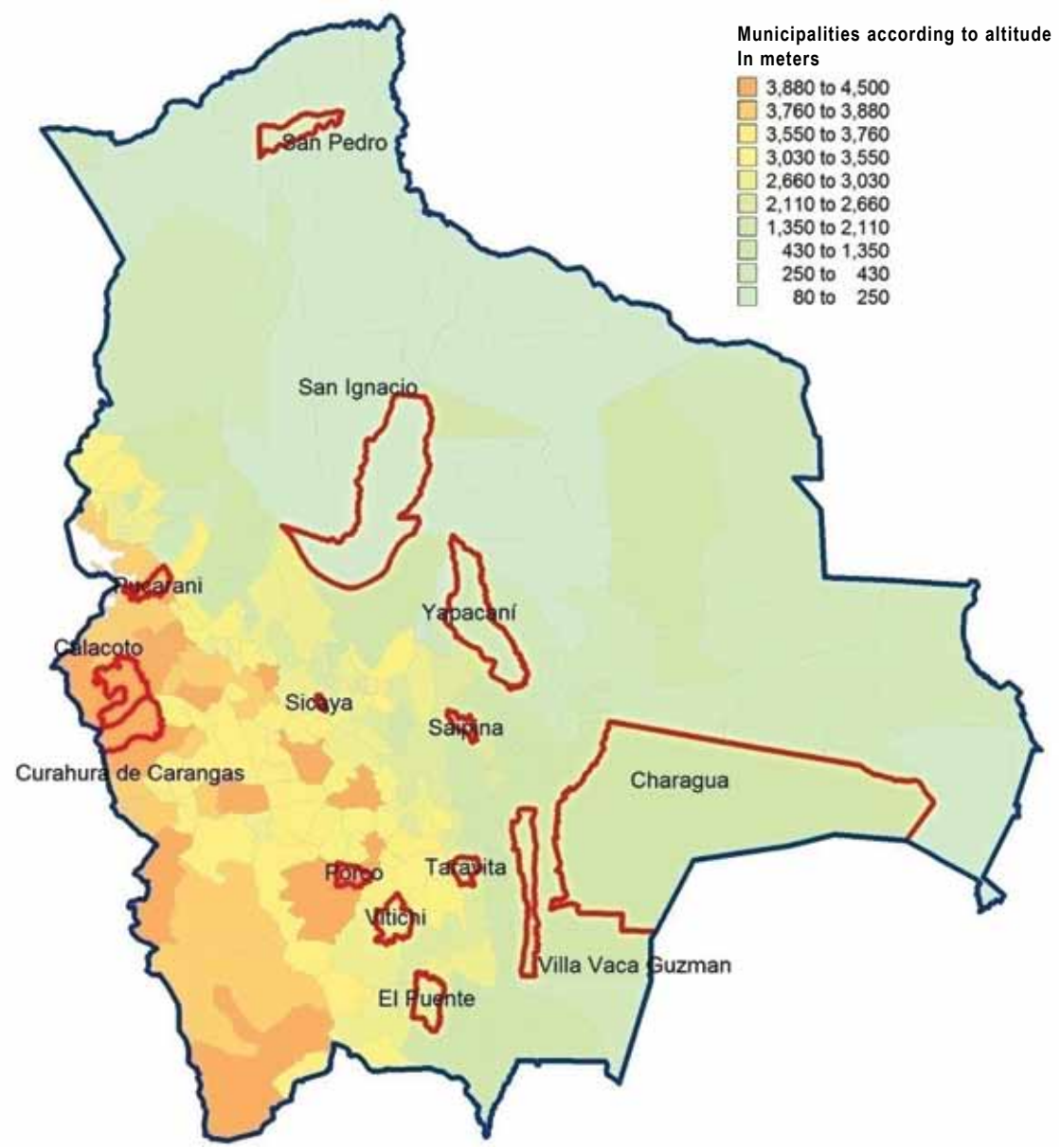


TABLE 13. SOCIAL INDICATORS

	Municipality	*Poverty incidence*	*Annual per capita income (US$)*	*Life expectancy (yrs)*	*Human Development Index*
1	Tarvita (Villa Orias)	91.1%	1,129	54.9	0.41
2	Villa Vaca Guzman	55.1%	966	62.6	0.54
3	Calacoto	75.8%	697	58.9	0.56
4	Pucarani	69.6%	612	59.8	0.52
5	Sicaya	82.8%	1,048	58.8	0.47
6	Carangas Curahuara	69.9%	811	65.5	0.57
7	Vitichi	67.1%	601	59.5	0.50
8	Porco	24.7%	1,026	60.7	0.57
9	El Puente (Tomayapo)	61.8%	1,325	62.9	0.54
10	Yapacaní	39.9%	1,498	65.3	0.62
11	Charagua	52.0%	1,214	61.9	0.57
12	Saipina	35.6%	1,497	61.5	0.59
13	San Ignacio	66.3%	2,142	63.6	0.59
14	San Pedro	82.6%	1,461	54.8	0.53

The sample shows 14 municipalities with an HDI below the national average (0.641).

TABLE 14. POPULATION SIZE AND DENSITY

	Municipality	*2002 population*	*Urban population*	*Rural population*	*Area (km^2)*	*Population density (inhabitants per km^2)*
1	Tarvita (Villa Orias)	15,166	0	15,166	1,830	8.3
2	Villa Vaca Guzman	10,748	2,327	8,421	4,024	2.7
3	Calacoto	8,818	0	8,818	3,700	2.4
4	Pucarani	26,802	0	26,802	924	29.0
5	Sicaya	2,235	0	2,235	256	8.7
6	Carangas Curahuara	5,278	0	5,278	2,296	2.3
7	Vitichi	11,298	0	11,298	1,963	5.8
8	Porco	5,959	0	5,959	1,023	5.8
9	El Puente (Tomayapo)	10,663	0	10,663	2,477	4.3
10	Yapacaní	31,538	14,589	16,949	9,218	3.4
11	Charagua	24,427	2,737	21,690	72,223	0.3
12	Saipina	5,350	2,394	2,956	406	2.13
13	San Ignacio	21,643	8,893	12,750	24,978	0.9
14	San Pedro	1,082	0	1,082	2,623	0.4

Sample: 3 municipalities with large populations, 9 municipalities with exclusively rural populations, 1 large town in area terms, 4 municipalities with high or medium population.

TABLE 15. CLIMATE

	Municipality	*Altitude (meters)*	*Average annual temperature*	*Annual precipitation (mm)*	*Climate*
1	Tarvita (Villa Orias)	2,480	15	400	Temperate/ subhumid
2	Villa Vaca Guzman	1,117	21	748	Warm humid
3	Calacoto	3,900	7	400	Dry cold
4	Pucarani	3,846	11	550	Cold
5	Sicaya	2,500	17	700	Dry temperate
6	Carangas Curahuara	3,968	5	400	Cold
7	Vitichi	3,020	15	394	Temperate
8	Porco	4,050	13	400	Cold
9	El Puente (Tomayapo)	2,300	17	500	Temperate
10	Yapacaní	288	2,24	1,972	Hot humid
11	Charagua	735	23	900	Warm dry
12	Saipina	1,360	8,20	600	Warm dry
13	San Ignacio	160	2,25	1,916	Hot humid
14	San Pedro	267	26,0	1,920	Hot humid

Sample: 7 municipalities have dry climates, 4 municipalities cold climates, 4 towns in the Altiplano, 6 in low-lying areas.

TABLE 16. HOLDRIDGE LIFE ZONES

	Municipality	*Life Zone 1*	*Life Zone 2*	*Life Zone 3*	*LIfe Zone 4*
1	Tarvita (Villa Orias)	Subtropical dry forest			
2	Villa Vaca Guzman	Subtropical dry forest			
3	Calacoto	Cool temperate steppe			
4	Pucarani	Cool temperate rainforest	Temperate rain forest		
5	Sicaya	Temperate dry forest			
6	Carangas Curahuara	Cool temperate steppe			
7	Vitichi	Cool temperate steppe	Prickly scrub cold temperate steppe	Subtropical thorn scrub	
8	Porco	Cool temperate steppe			
9	El Puente (Tomayapo)	Prickly scrub cold temperate steppe			
10	Yapacaní	Subtropical rainforest	Rainforest	Subtropical wet forest	
11	Charagua	Tropical dry forest	Subtropical dry forest	Tropical dry forest	
12	Saipina	Subtropical dry forest			
13	San Ignacio	Subtropical rainforest	Rainforest	Tropical dry forest	Subtropical rainforest
14	San Pedro	Subtropical rainforest			

5. LIVELIHOOD STRATEGIES IN THE STUDY AREA

A livelihood strategy can be described as a hierarchical combination of economic activities which generate resources to provide for family subsistence.

Livelihood strategies are complex because they comprise a number of different economic activities, depending on the resources and opportunities possessed by families, as well as the constraints affecting households.

One of the factors in terms of constraints and opportunities is the diverse agro-ecological nature of the land, particularly regarding its soil composition and relief. This varies considerably, even over small areas, e.g., within the same community separate areas may produce vegetables, potatoes, corn, etc. As a result a wide diversity of livelihood strategies can exist in the same community.

A further aspect is that livelihood strategies are complex. While one activity may predominate, others may also exist which, together with the main activity, combine to form the family´s or community´s livelihood strategy. Families engaged in livestock raising also often devote time to cropping as well as making and selling other products, although such families are generally described as "livestock raisers" in view of their core income-producing activity.

Livelihood strategies are also dynamic. Families may often change or rearrange the activities that underpin their livelihoods when new opportunities or constraints appear. These are frequently the result of greater or lesser availability of resources (e.g., more capital, young adults leaving home, cattle herd reduced by death, etc.).

CLASSIFICATION OF LIVELIHOOD STRATEGIES

The classification below is based on the main economic and income-producing activity of households.

Strategies Based on Rainfed Agriculture

The main activity is rainfed agriculture, i.e., not requiring irrigation. In the Altiplano and valleys this is generally based on a combination of agriculture and some livestock raising. Although the main income source is growing crops, livestock raising provides inputs as well as labor for the former. In the Plains and Chaco, where most farms are devoted solely to agricultural production, this dual activity is much less common. Potatoes are generally grown in the areas with good soils and high humidity, cereals in the drier areas with poorer soils, and fruit in hot and humid areas.

Strategies Based on Irrigated Agriculture

These involve growing products that can fetch a high market value and require irrigation to obtain competitive returns. Such strategies tend to be specialized and well integrated into the market. The main agricultural activities in this sector involve growing counter-season crops (potatoes, corn, onions, fruit, etc.), vegetables (in areas near cities) and fruit (in hot dry areas).

TABLE 17. LIVELIHOOD STRATEGIES

	Sector	*Subsector*	*Predominant economic activity*
Agricultural	Agriculture	With irrigation	Vegetables
			Fruit
			Counter-season crops
			Others
		Without irrigation	Cereals
			Potatoes
			Others
	Animal husbandry	Extensive	Cattle
			Camelids
			Others
		Semi-stables	Cattle
			Others
	Forestry		Hunting
			Fishing
			Extraction or harvesting
Employment	Employment	Local	Agricultural day laborer
			Casual labor, other jobs
		Temporary migration	Seasonal agricultural work
			Seasonal urban employment
Self-employed	Manual activities		Bricklayer
			Carpenter
			Blacksmith / Mechanic
			Craftsman
	Services		Trade
			Manufacturing
			Sales
			Transport

Strategies Based on Extensive Livestock

The main economic activity in this sector is free-range livestock-raising on natural pasture land. The main animals in the category are cattle (in the lowlands) and camelids (in the Altiplano), both reared for their meat. Sheep and goats are also bred in smaller numbers. Extensive livestock raising activities are often combined with small-scale subsistence agriculture.

Strategies Based on Intensive Livestock

Intensive livestock (mainly cattle) raising is undertaken generally in the vicinity of large cities, mainly for milk production. The milk-producing farms generally grow irrigated crops of alfalfa to feed the semi-stabled herds (supplemented by balanced feed purchased in the towns). Beef cattle, pigs, and poultry are also raised on a smaller scale in this category.

Forestry-based Livelihood Strategies

These strategies can generally be found in the Plains Region where families have access to the biodiversity of the forests and rivers, e.g., hunting, fishing, and forest resources extraction. Small plots are also often cultivated for family consumption.

TABLE 18. LIVELIHOOD STRATEGIES IN THE SAMPLE

	Livelihood approach					
Macro-region	*Agricultural*	*Agricultural and other*	*Employment*	*Self-employed*	*Total*	*n*
Altiplano	42%	47%	0%	11%	100%	19
Chaco	50%	40%	10%	0%	100%	10
Plains	86%	14%	0%	0%	100%	14
Valleys	59%	37%	4%	0%	100%	27
Weighted average	**59%**	**36%**	**3%**	**3%**	**100%**	70

Source: Prepared with data from family interviews; (n = 70 families)

Employment-based Livelihood Strategies

The poorest families in the communities derive the bulk of their income from selling their labor as casual farm hands (*jornaleros*). Such families also often cultivate small vegetable gardens and raise a few animals.

Other families live from the income derived from temporary migration (family members traveling to seek work in the cities or in other farming areas). Some families live on the wages of one or more family members who work as permanent employees of the state (usually teachers) or of mining and oil companies.

Strategies Based on Trades

Other families receive the bulk of their income from a trade practiced by one or more family member. These are people who have received technical training, usually from parents, and have a small amount of capital: masons, artisans (leather or ceramic products), blacksmiths, carpenters, etc.

Strategies Based on Services

Some communities have families principally engaged as services providers—mainly truck or bus-drivers, small shopkeepers/traders, and others who make a living from renting out corn-milling equipment, etc.

From the above table it can be seen that fewer than two-thirds (59 percent) of families live from agricultural activities, while the remaining third (36 percent) combine agricultural activities with paid jobs or are self-employed. Notwithstanding the small sample size, it is clear that agriculture forms the basis for the livelihoods of families living in the communities. A third of the families also supplement these activities with non-agricultural work.

SOCIOECONOMIC STRATA

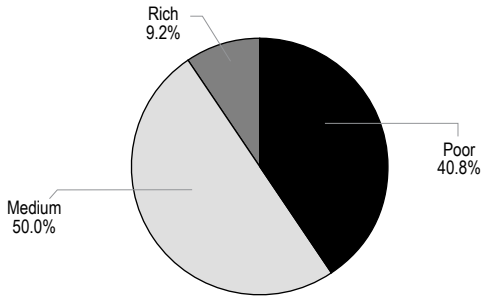
Socioeconomic self-stratification enabled our researchers to classify households and families in the communities under three main headings or strata: "poor," "average," and "rich,"[5] using the indicators selected by the communities and taking account of land tenure, livestock ownership, family social position, child employment, type of housing, etc.

Figure 17 shows the proportion of families in the three categories on the basis of the sample of 70 communities studied. 9.2 percent of families in the community were considered "rich," 40.8 percent "poor," and the remaining 50 percent "average." These figures probably fail to tell the whole story since significant variations exist from one community to another.

The socioeconomic strata classification presented in this study is a relative and very approximate ranking constructed by comparing one family to another in a

5 In the study area all the families are considered to be poor according to the definition of poverty by the National Statistics Institute, and the sample was selected with this in mind. As a result, the description of each stratum should be: the poorest, the intermediate poor, and the less poor. However, in order to make the document easier to read we decided to adopt the following definitions: "poor," "average poor," and "rich" (using inverted commas).

FIGURE 17: SOCIOECONOMIC STRATIFICATION IN THE COMMUNITIES



Source: Prepared from Enquiry Form 4.

given community (i.e. poor families in one community may differ significantly from poor families in another).

Table 19 indicates degrees of socio-economic differentiation in the communities: the so-called "rich" own between 5–10 times more assets than "poor" families, particularly as regards ownership of animals.

On the other hand, analyzing the figures by macro-region, it appears that the differences between strata are higher in the Plains.

Figure 18 shows that productive assets within each stratum can vary significantly, given that in each macro-region communities possess different productive skills. Communities in the Altiplano, for example, which raise camelids tend to own many more animals than other communities engaged in agricultural pursuits.

LIVELIHOOD STRATEGIES BY SOCIOECONOMIC STRATA.

Livelihood strategies and socioeconomic status are closely linked. A particular livelihood strategy is governed not by what families or communities desire of their own free will but by a set of overriding factors that must be met. A dairy-based livelihood strategy calls, for example, for a substantial amount of capital for investing in livestock and infrastructure; such families need irrigated land for growing fodder and to be close to markets where they can sell their milk. The capital invested in dairy units is generally 10 to 20 times greater than that invested in rainfed agricultural units.[6] This means that only the richest families in the community are dairy farmers, earning over ten times more than families living off rainfed agriculture.[7]

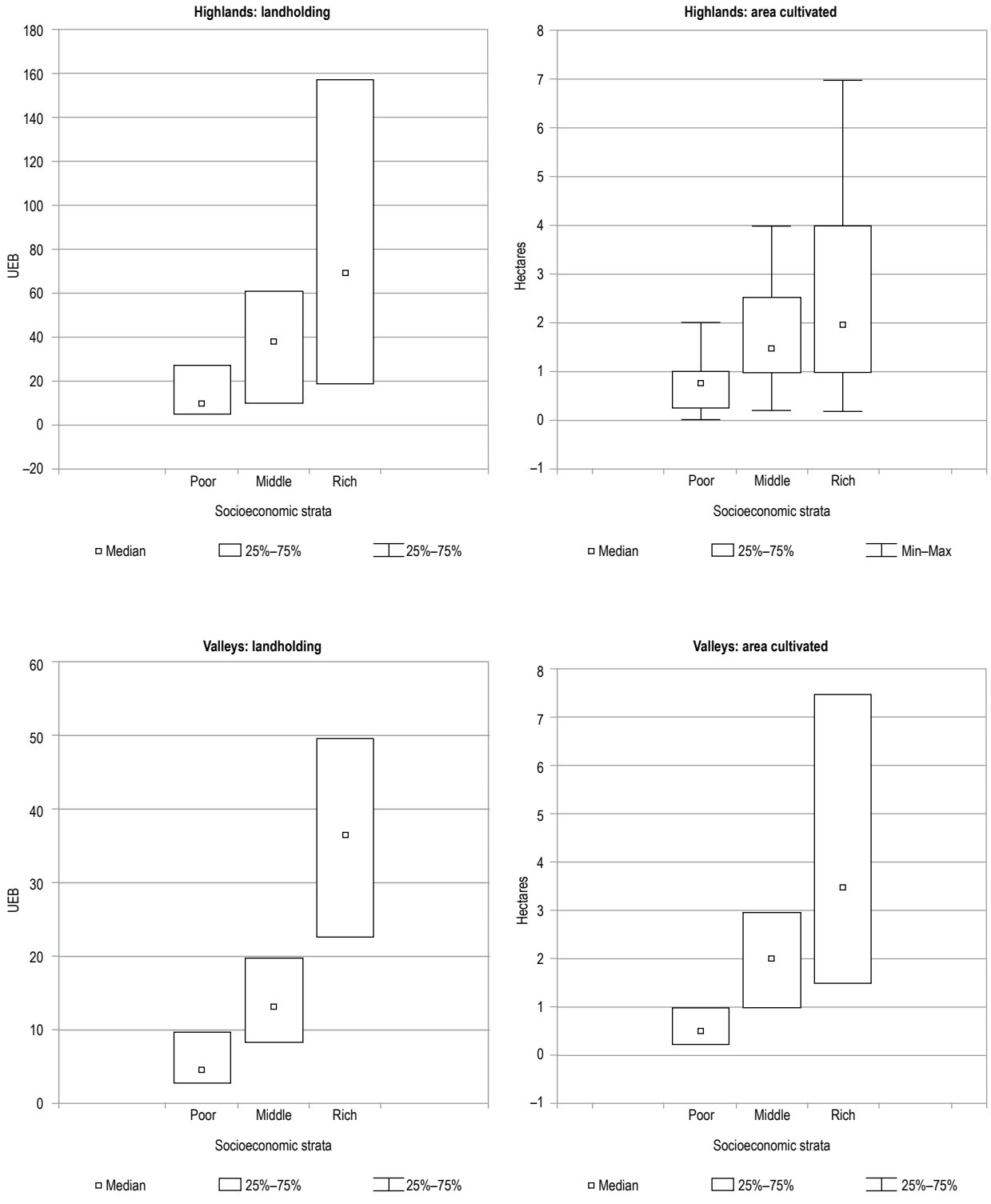
6 Wizke Emilie: *Study of production systems in the Yotala Valley*, page 25.
7 Idem, page 33

TABLE 19: FAMILY AGRICULTURAL ASSETS BY STRATA AND MACRO-REGION

			Area cultivated (Ha)		*Livestock ownership (AUE)*	
Macro-region	*Stratum*	*Valid N*	*Mean*	*Std.Dev.*	*Mean*	*Std.Dev.*
Altiplano	Poor	20	0.8	0.7	7.14	9.13
	Average	20	1.6	1.1	46.9	43.2
	Rich	16	2.8	2.4	94.1	83.4
Valleys	Poor	25	0.9	0.8	6.0	3.3
	Average	25	2.2	1.5	4.14	6.4
	Rich	20	4.4	3.3	37.0	7.15
Plains	Poor	15	1.5	1.1	1.3	2.3
	Average	15	4.4	5.6	5.3	9.9
	Rich	15	8.5	10.8	9.13	25.0
Chaco	Poor	10	1.2	0.8	3.1	3.4
	Average	10	3.0	1.7	9.0	7.6
	Rich	10	4.5	2.1	1.20	3.12

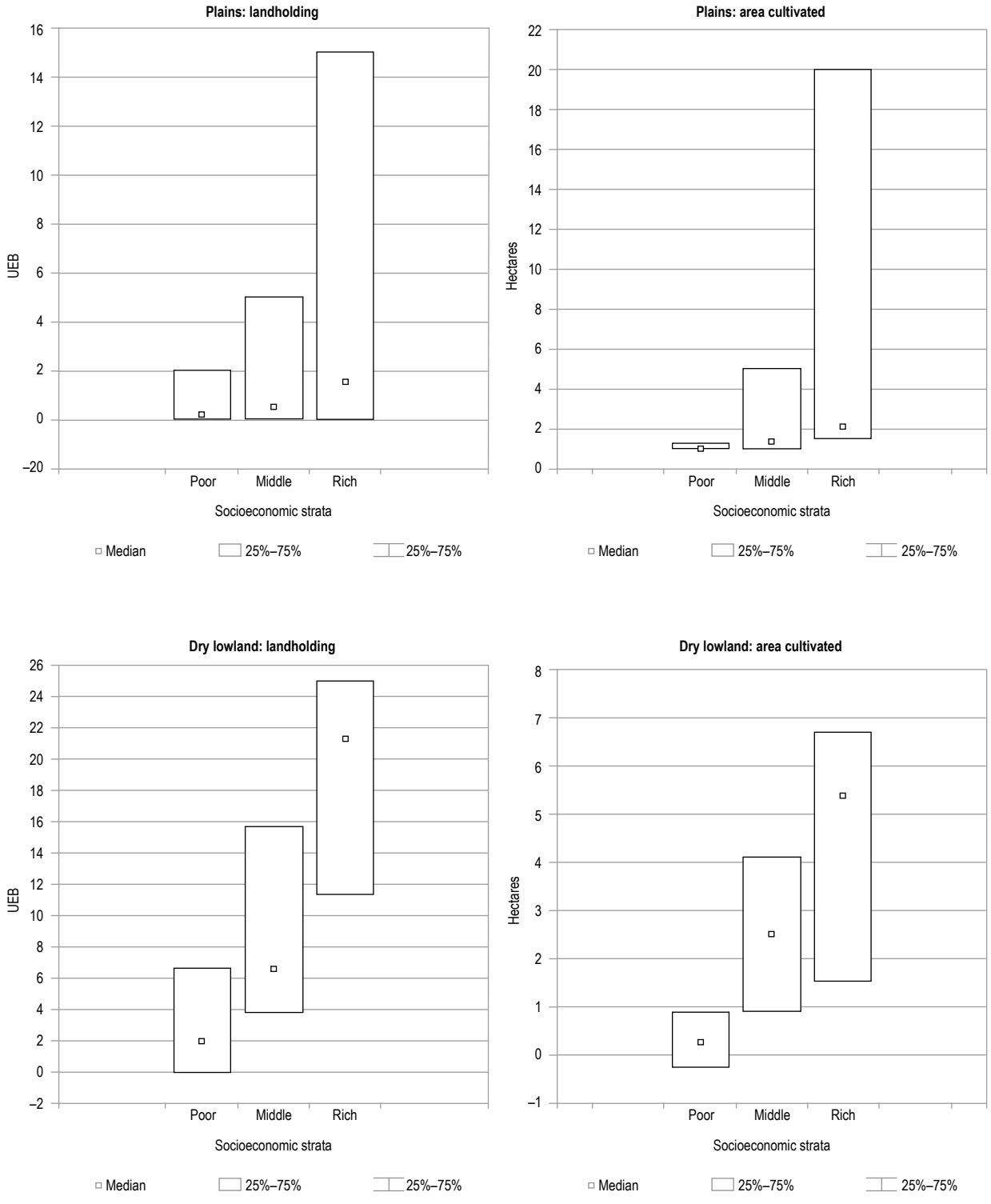
Source: Enquiry Form 4
UEB: Animal Unit Equivalent

FIGURE 18: RURAL FAMILIES (AGRICULTURAL ASSETS) BY STRATA AND MACRO-REGION



Source: Prepared from Enquiry Form 4

FIGURE 18: RURAL FAMILIES (AGRICULTURAL ASSETS) BY STRATA AND MACRO-REGION



Source: Prepared from Enquiry Form 4

Although separate communities possess a variety of livelihood strategies general trends can be identified from the analysis of the results of the family interviews[8] designed to establish the relationship between socioeconomic strata and livelihood strategy.

The livelihood strategy of the "poorest" families tends to be based on:

- Rainfed agriculture'
- Small-scale livestock farming; or
- Casual agricultural employment in the community (jornaleo) and seasonal migration.

The strategy of the "intermediate" families revolves around:

- Rainfed and some irrigated agriculture
- Extensive livestock farming; or
- Casual agricultural employment and seasonal migration

"Rich" families base their strategies on:

- Irrigated (and some rainfed) agriculture;
- Semi-stabled livestock, dairy produce, large-scale livestock rearing; or
- Self-employed activities (services and trades).

TEMPORARY MIGRATION AS A LIVELIHOOD STRATEGY

Temporary migration applies to rural family members who travel to nearby towns and cities or to mining centers or other agricultural regions to seek temporary employment.

Temporary migration is now commonplace in rural communities. It meets a number of different needs, but the main one is to generate additional income for families back home. The general rule (exceptions exist) is that temporary migrants consist of men of working age leaving the communities in search of work while the rest of the family stays behind to care for the animals and crops. In the interviews conducted in this study we found that in all the 25 families where this practice was common temporary migration was restricted to the menfolk.

We also discovered that migration is a practice that families prefer to avoid, given the uncertain outcomes. Migrants do not always find work and return to their communities either penniless or sick (or both). The top priorities of many families in such circumstances is to avoid migration and seek to expand the productive capacity of their farms. This point was put succinctly by a resident of Barrancas:

> *My husband left home to find work at sugar cane harvest time in another area, but he suffered a lot. Sometimes he returned sick from mosquito bites and there were occasions when he returned with no money since the rains brought cutting to a halt. But we managed to irrigate our land and he thankfully has no longer needed to leave home for the last three years.* (Interview with Maria Quispe, community of Barrancas, Valleys Region).

Who Are the Temporary Migrants?

The bulk of the 'migrant' population consists of young men keen to end dependency on their families and earn their own money. Temporary migration for them is a kind of rite of passage into adulthood.[9] Another important group consists of smallholder (*minifundista*) families with little land (or with no land) who depend on rainfed farming but who are unable to grow enough to support themselves. These families organize their activities to enable one or more family members to migrate in search of work for several weeks a year.

Who Are the Non-migrants?

The interviews revealed two categories of families where migration was not an issue: families with no need to migrate and those who were unable to do so.

The first category includes the less poor families in the community with sufficient irrigated land and/or are able to earn money from such activities as providing transport, milling services, etc. The second category generally consists of:

8 The sample is too small to produce significant statistical data to support these trends.

9 Vargas Miriam, *La migración temporal en la dinámica de la unidad domestica campesina,* page 150.

- Families with no adult male, as in the case of widows with young children;
- The elderly, where the male is too old to seek work;
- Families where the male has some disability that prevents him from working.

These families (generally the poorest, landless families in the community) do not possess the wherewithal to seek work elsewhere and family members are obliged to work locally as casual laborers within the community.

In summary, temporary migration is an approach taken specifically by poor families with insufficient productive resources. It is however an approach that is not open to all such families for one reason or another.

Temporary migration should not be confused with the traditional campesino practice of growing crops in several (not necessarily contiguous) ecological zones, involving family members being away from home for several weeks at a time.

6. CLIMATE CHANGE IN BOLIVIA

This chapter examines community views on recent manifestations of climate change in their areas and the change scenarios for the coming years.

THE SPECIALISTS´ VIEWPOINTS

Numerous efforts are currently afoot in Bolivia to develop climate scenarios from climate modeling. The scale used by these models has gradually become more precise and projections therefore more reliable.

In terms of temperatures, almost all the models[10] reveal that Bolivia will be hotter in the coming years, with average temperatures rising by between 0.8 and 3.9^{0}C over the next 100 years (the IS92a scenario).

In terms of rainfall, however, the scenarios are highly varied and at times contradictory. Some scenarios predict an increase in rainfall while others suggest less rainfall. Nevertheless, all the scenarios appear to concur on one point: that the rainy season will be shorter and more intense.

VIEWS OF THE COMMUNITIES

Heirs to a rich tradition, Bolivia's communities handle climate indicator systems which enable them to interpret the changes in natural phenomena for identifying changing trends and predicting climate variability. Given that this traditional practice is common to all the communities surveyed, the study opened a debate with the communities to try and identify past medium- and long-term climate change trends as a basis for projecting future climate scenarios.

This discussions revealed that many of the climate indicators employed by traditional communities tend to be increasingly ineffective. Many asserted that it was no longer possible to predict weather patterns as in previous generations due to the climate change process (including greater climate variability). Regardless of the new scenario the communities nevertheless continue to pay close and regular attention to the climate, observing changes and new developments. Given that their livelihoods depend on the climate, the communities were in an excellent position to provide accurate descriptions of the changes observed over many years.

CHANGE TRENDS IN RECENT YEARS

One of the main conclusions of the study is that in all the communities, regardless of the ecosystems in which they survive, it would appear that the climate is changing. Communities, accustomed to living with climate variability, are now more concerned with the change trends in the climate. The change trends were precisely identified by our interlocutors and thus it was possible,

10 In this paragraph we refer to the study undertaken by the PNCC in which a comparative analysis was done of the climatic models HADCM2, HKHI, GISSEQ, MAGICC y SCENGEN, employing three CO^2 emission scenarios: IS92a, IS92e, IS92c. The results were applied in a vulnerability study of Bolivia´s main ecosystems. See PNCC, *Escenarios climáticos* 2007.

using the process of participatory analysis, to construct climate scenarios for each community.

Increasing Temperatures

The majority of the communities considered that over the past 20–30 years temperatures had risen. They observed that the sun burns hotter and longer, that river water is warmer, that the earth is drier, and that wild fruit ripens quicker than before. Furthermore, they reported that animals, insects, plants, and crops more typical of warmer climes had begun to appear. The communities in the valleys and plains observed that the winters were less cold.

Some comments are worth recording in this respect:

- *Now it is very hot and the sun burns down on us, particularly in the daytime in winter and spring.* (Chaquilla Community Workshop, Altiplano).
- *By day the burning heat causes skin cancer and headaches.* (Pucarani Community Workshop, Altiplano).
- *The sun is stronger, the soil is drier, new plant diseases are occurring.* (La Silla Community Workshop, Valleys).
- *The heat brings more flies and mosquitoes in January and February.* (Chapicollo Community Workshop, Valleys).

On the other hand, the Altiplano communities reported increased frequency and intensity of frost (attributed to drier air).

Less Water

Twelve of the 14 municipalities reported a trend toward decreased rainfall, and in most cases a shorter rainy season, with heavier precipitation than previously.

> *The rains which used to begin in the first half of December now come in January* [...] *They always used to end in the first half of April but now they end in March.* (Contorno Calacoto Community Workshop, Altiplano)

> *[The rains] used to start in September but they now start in December and end in February, not in March, as previously.* (Charagua Community Workshop, Chaco)

> *The rains always began in September or October, whereas nowadays they begin in December or sometimes January. They used to end in May but now they stop earlier, in March.* (El Puente Community Workshop, Valleys)

> *Previously the rains began earlier, in the month of October, but they now start in November. It used to rain until April but now the rains stop in mid-March.* (Yapacani Community Workshop, Plains)

The indicators identified by communities, in addition to a shorter and heavier rainy season, showed lower levels of water in the rivers and catchment basins. Some of these were reported to have dried up altogether. A trend had also been towards less natural vegetation, falling crop yields, and early budding of trees.

Only the municipalities of the Amazon (San Ignacio and San Pedro Moxos) reported the rainy season beginning earlier and ending later, together with heavier rainfall and flooding.

In all the communities there was general agreement that rains were more torrential, with more water falling over shorter periods and causing erosion and flooding.

Other Climate Changes

An increase of more frequent and intensive hailstorms was often mentioned in the course of our workshops. It was also stated that winds were stronger over recent years, attributed by the communities to a rise in deforestation and regarded by many as the cause of less rainfall, in the belief that higher winds were responsible for dissipating rain-bearing clouds.

FUTURE CLIMATE SCENARIOS

From their observation of trends over the past 20–30 years, the communities identified future climate scenarios.

Major Changes

The most-cited trend was the increased frequency of drought. Twelve out of the 14 communities studied

referred to this. One community in the Amazon opined that the future would bring heavier rainfall, concentrated into shorter times and interspersed with periods of drought.

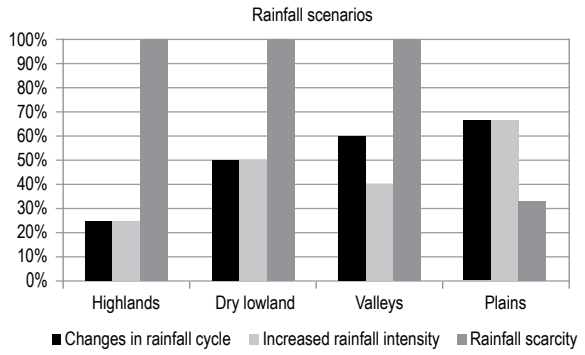
The future climate scenarios advanced by the communities predicted that drought would be the main problem (more heat and less water). Moreover the communities were particularly concerned that the future decline of water availability would go hand in hand with poorer distribution of this resource. The "Indian Summer'" short dry spells during the rainy seasons (*veranillos*) were forecast to be longer and more frequent, with the rains starting later and ending earlier, with more storms and torrential downpours.

This perception by community dwellers coincides with climate scenarios developed from Global Climate Models (GCMs), which predict a future with more heat and more pressure on water resources. Annual rainfall in absolute terms is unlikely to diminish but will be concentrated in shorter periods of heavy rainfall.

Figure 19 shows that 100 percent of the communities of the Altiplano, Valleys and the Chaco believe there will be a shortage of rain, while in the Plains 30 percent of the communities reckoned lack of rain would be a problem.

The reduced and increasingly intense rainy season is the main change identified by all the communities in Bolivia´s four macro-regions, particularly by communities located in the Plains region. Meanwhile, the communities in the Amazon part of the country predict heavier rainfall accompanied by increased flooding.

FIGURE 19. CLIMATE SCENARIOS IDENTIFIED BY COMMUNITIES



Other Climate Changes

Virtually all the communities in our study considered that wind frequency, duration, and intensity would increase, causing severe damage mainly in the Chaco and Plains, especially in areas where the windy period coincides with harvest time.

While the Altiplano communities believe that periods of frosty weather are likely to increase in frequency and intensity, communities in the Chaco, the Plains and the Valleys regions predict decreased frost.

According to three of the four communities interviewed in the Valleys region, hailstorms are likely to be more frequent, and fears were raised about possible calamitous crop losses as a result.

7. THE IMPACTS OF CLIMATE CHANGE

The study called for communities to reflect on the possible impacts of climate change on their livelihoods id the prioritized scenarios become reality. We regarded this as a necessary methodological requirement, involving a hypothetical and general rather than quantified approach, in order to gain an idea of how adaptation measures could be envisaged and formulated. The following sections are not therefore an examination of the impacts of climate change (which falls into a different category and which we believe would be very interesting to undertake), but rather reflect the outcomes of discussions with the campesinos about the ways they themselves saw future scenarios. Analyzing the results is an interesting exercise because it helps toward a better understanding of the adaptation measures prioritized by the campesinos.

THE EFFECTS AND IMPACTS OF DROUGHT

According to the campesinos, water shortages have multiple effects on communities. The results of our discussions in the 14 communities are presented in the following table:

Decrease or Loss of Crops

All the communities were aware of the immediate effects of drought: the loss or decline of crop and livestock production. Prolonged drought involves total loss of the harvest, while "normal" periods of drought generally lead to decreased yields. Ten of the 14 communities reported experiencing severe drought over the past 30 years.

This can be confirmed by the Agronomy Component Study which stated that drought years (the dry scenario) would cause significant decreases in the yields of all the crops studied (see Table 21):

Citing a study by the Pan American Health Organization (PAHO), the PNCC estimates that the 1983 drought led to a loss in Bolivia´s productive sector of around US$1,174 million dollars, equivalent to over 15 percent of total GDP and 50 percent of agricultural GDP.

TABLE 20. EFFECTS AND IMPACTS OF DROUGHT

	Effect or impact	*Communities*
Effects	Decrease or loss of production	100%
	Loss of genetic material	86%
	Less food eaten	100%
	Less water drunk	54%
	Less hygiene	46%
Impacts	Lower incomes	100%
	Children's education affected	62%
	More family illnesses	100%

Source: Community Workshops

TABLE 21. EFFECTS OF CLIMATE CHANGE ON YIELDS (DRY SCENARIO)

Crop	
Potatoes	Decreased production
Corn	Decreased production
Quinoa	Decreased production

Source: Agronomy Component Study

Loss of Seeds

According to our surveys, given the small size of the crops managed by smallholder campesinos, the losses caused by drought forced families to consume their entire harvested crop, including the portion normally reserved for seeding in the following season.

In the Qhawasiri Community (Valleys), for example, the 1983 drought was so severe that virtually all the seed potatoes were lost and the menfolk were forced to seek jobs in the cities to obtain the money needed for purchasing new seeds. In the aftermath of the drought demand for seeds was such that prices increased significantly. The generalized shortage of potato seeds led to new foreign varieties being imported which caused the spread of previously unknown diseases, blight and parasites such as the white grub locally known as *lagartu*.

Thus, one of the major consequences of drought is the loss of genetic material, with many <<some??>> species and varieties disappearing from vast regions of the country and in many cases in danger of extinction.

Famine

The communities also revealed that drought had an immediate and direct effect on the amount and quality of food available for human consumption. The community workshops without exception all referred to drought as being synonymous with famine, although this did not affect everyone uniformly. However, falling harvests as the result of drought tended to affect most families, causing hunger, while a small proportion of families (the 'less poor'), managed to escape the worst effects. Drought for the latter involved using up the money or food they had managed to put aside for this eventuality.

As indicated in Tables 22 and 23 above, yield reduction affects everyone, but particularly the "poor" and "average" campesinos, whose production fails to supply them with enough to eat or store. The "average" campesino family cultivating three acres per year will see their agricultural income drop due to drought from US$4,725 to US$3,465, which is insufficient to cover their consumption expenditure of US$ 3,918 and resulting in a net loss of around US$450, meaning the family would need to supplement its income with other income-producing activities in order to maintain its

TABLE 22. FAMILY INCOME IN NORMAL YEARS (PAMPAJASI COMMUNITY)

	Units	*"Poor" Campesinos*	*"Average" Campesinos*	*"Rich" Campesinos*
Average yield (*)	US$/ha	1,400	2,100	2,800
Input unit	US$/ha	350	525	700
Added Value Unit	US$/ha	1,050	1,575	2,100
Cultivated area	Ha	2	3	4
Total value added	US$	2,100	4,725	8,400
Household consumption (**)	US$	3,134	3,918	4,701
Saving	US$	–1,034	807	3,699

Source: Data from Enquiry Form 4.
(*) Average yield of major crops (potato, barley) in normal years.
(**) Extrapolated from UNDP data (2001 HDI), Pucarani Municipality.

TABLE 23. FAMILY INCOME AND DROUGHT-REDUCED YIELDS OF 20 PERCENT (PAMPAJASI COMMUNITY)

	Units	*"Poor" Campesinos*	*"Average" Campesinos*	*"Rich" Campesinos*
Potato equivalent yield	US$/ha	1,120	1,680	2,240
Input unit	US$/ha	350	525	700
Value added	US$/ha	770	1,155	1,540
Cultivated area	It	2	3	4
Total value added	US$	1,540	3,465	6,160
Household consumption (**)	US$	3,134	3,918	4,701
Saving	US$	–1,594	–453	1,459

Source: Data from Enquiry Form 4.
(*) Average yield of major crops (potato, barley) in dry year.
(**) Extrapolated from UNDP data (2001 HDI), Pucarani Municipality.

level of consumption. But, as explained by the families interviewed, during a drought many people migrate in search of work, and wages tend to fall in view of the competition for jobs, As a result, the migrants fail to achieve sufficient cash to offset the family´s losses. Such families have no other choice but to reduce food consumption.[11]

> *In the drought we have less food all round: fewer beans, less corn, less kumanda. We simply have to make do by drinking less milk and eating less meat* (San Francisco Community Workshop, Chaco.)

> *In times of drought production tails off and we have less to eat. We have to buy food from the city which is less nutritious. You simply eat less meat and cheese.* (El Puente Community Workshop, Valleys).

Decreased Income

All of the communities indicated to our researchers that drought causes a drop in incomes owing to reduced or lost agricultural and livestock production. Some communities also reported that even handicrafts production was affected by the drought.

> *There are no surplus agricultural products to sell.* (Chapicollo Community Workshop, Vitichi, Valleys)

> *The sale of animals such as goats and sheep falls off.* (Caña Cruz Community Workshop, El Puente, Valleys)

> *Significant decreases in homemade clothing items made from our camelid wool.* (Jila Uta Manasaya Community Workshop, Carangas Curawara, Altiplano)

Disease

In all the communities surveyed drought was reported to be the cause of disease (mainly a variety of infections and diarrhea) resulting from undernourishment and from drinking stagnant and polluted water.

> *Drought affects the health and welfare of all of us. People here are eating less and badly.* (Chaquilla Community Workshop, Porco Municipality)

62 percent reported that drought had a negative effect on children's education for two reasons: malnourished children were unable to learn properly and children ceased going to school in order to assist their parents to deal with problems caused by drought.

11 A study undertaken in the valleys during the 1998 drought reveals that it is the poorest families who are forced to reduce their levels of consumption—cutting down on the number of daily meals. Morales et al. 2001: *Estrategias campesinas para enfrentar la sequia*. Page 92. PIEB.

Children cannot learn on a virtually empty stomach. (Chapicollo Community Workshop, Vitichi Municipality, Valleys).

SECTORS WORST AFFECTED BY DROUGHT

The families in the lowest socioeconomic strata are the most affected by drought. They are more susceptible to the effects of drought since: (i) they farm only rainfed land; (ii) their land is more drought-susceptible, being short of organic matter and with low moisture retention; and (iii) they are short of resources for coping with drought, possess only small plots for growing a limited amount of crops and have no reserves to get them through the bad years.

Our interviews revealed that the worst affects of drought are suffered by families who depend on the rainfed cultivation of potatoes. The campesinos knew that the potato is a crop requiring plenty of water and that water shortages were bound to have a more negative effect on it than on other crops. The loss of a potato crop is expensive, not only because the price fetched by the sale of potatoes is normally relatively high (and the losses correspondingly greater), but also because inputs (especially seed) cost significantly more than for other crops. Families who had lost their seed potatoes during a drought reckoned that it took two to three years to recover them.

My potato crop is not what it was before the drought three years ago. I still do not have enough seed potatoes to go round. But I am slowly recovering, working in partnership with others who do have seeds. (Julio Padilla, Kanalla Community, Valleys).

Other livelihoods that are seriously affected by drought are those based on extensive livestock farming. Drought causes a decrease of native vegetation, particularly grassland fodder, due mainly to grass being slow to re-sprout after the winter and also to the fact that in the *veranillos* (dry spells during the rainy season) the grass grows much slower. It follows that animals have less grass to graze on. Drought also causes springs and river catchment areas to dry up, thereby forcing cattle to cover long distances in search of water.

Severe droughts cause not only the decline of livestock productivity but also the deaths of large numbers of animals and, for the campesinos, the destruction of productive capital. After periods of drought, campesinos who had who lost their herds were generally forced to look elsewhere for work.

Many people who lost their cattle had to go and live somewhere else. Some went to Chile, others went to work in the mines. It is difficult to get a herd together again. Where would we find the money? (Gregorio Alvarado, Uta Manasaya Jila Community, Altiplano)

EFFECTS AND IMPACTS OF FLOODING

Two communities in the sample discussed the effects and impacts of floods. Both communities argued that flooding leads to:

- A drop in eating and living standards due to the loss of crop and livestock production, the difficulty of obtaining forest products, and from drinking bad water.

  Floods strongly affect food security because of crop losses. On the other hand we are forced to drink contaminated water. (Valparaiso Community Workshop, San Pedro, Plains)

- Significant flood damage to homes caused by humidity and sludge;
- Absenteeism at school because children are unable to attend school at peak flood times.

  During the flood families temporarily move to other places. Classes are cancelled until the flood subsides, the rains end and the mud dries up (Valparaiso Community Workshop, San Pedro Municipality)

- Spread of diseases such as malaria, diarrhea, malaria, fever and "evil eye" (conjunctivitis).

FAMILIES HARDEST HIT BY FLOODING

In the communities studied it was reported that flooding affected everyone's houses and plots of land. Those

TESTIMONY OF AIDÉE GIMENEZ, PRESIDENT OF THE INDIAN SUBCENTRAL CERCADO, BENI

Climate change for us is very serious since it brings more flooding. Over the last ten years we have had three major floods which have flooded communities and places that were never flooded before. My whole community is now under water - in some places it is up to a meter deep. Previously the floods were short but after five or six days things got back to normal. But now the water is with us for four months.

The water dries up after the flood leaving a layer of white clay on the ground. This prevents us from growing anything in the soil. Some say that this clay can be an advantage, but you have to know how to deal with it.

Flooding seriously affects our plantation. We planted chocolate trees but after a couple of years the water came and ruined them. The trunks and roots have all been eaten by insects. The same happened with our banana plantations. It looks like the insects have nowhere to live except in the roots of our trees and plants.

The bigger floods also kill off our fish. Flash floods bring everything to the ground: tree leaves and branches, and after a few days all the vegetation starts rotting and smelly water gets everywhere. I reckon that that is what kills off the fish.

with motor boats coped better since they were able to transfer their families and animals to other communities or move to higher ground. Families without boats, including the poorest members of the community, had to rely on assistance from neighbors.

> *I have a small boat and when the floods hit the community I was able move my family and pigs to Agua Dulce [a neighboring community that was not flooded], because around here there was a lot of mud and water.* (Interview with the family of Vicente Moreno, Valparaiso Community, Plains Region)

> *In the flood we had to make a high 'chachapa' (a high wooden pen) next to the guava tree to protect our animals [...] many of them drowned.* (Interview with Sanginez Marina, Valparaíso Community, Plains Region)

EFFECTS AND IMPACTS OF WARMING

Our study was also able to identify the effects in some communities of gradual climate warming. We found that warming had a number of negative effects on communities in the cold and temperate regions but was not a serious concern in the warmer areas. Of note was the fact that the gradual increase in temperatures over recent years had brought about major changes in people's livelihood strategies, either gradually over time or more rapidly from one year to the next.

One example of gradual climate warming was in the communities growing potatoes as their main source of subsistence, where climate change was gradually producing changes in the potato varieties. The traditional Andean species, usually grown in a long cycle, were being slowly replaced by Dutch potato varieties (short-growth cycle mainly for use as French fries). This change was observed in interviews with all potato growing families, both the Valleys Region and in the Altiplano. Communities reported that the acreage under Dutch varieties was increasing year by year at the expense of the local traditional potato species.

A further example, reported by all the communities in the Altiplano and Valleys Regions, is that livestock systems are altering as the result of reduced pasture availability. This was reported by all the communities in the Altiplano and Valleys regions. According to the campesinos, pastures were requiring more water as the climate heated up and sprouting was delayed after the end of winter. The upshot was that animals were unable to find the same amount of grass to eat and had taken to chewing grass roots, which obviously had negative effects on pasture recovery times. Due to lack of available food, the number of animals kept per family had begun to decline, causing food shortages in families and a manure deficit for fertilizing crops.

ABANDONING THE LAND IN THE OVEJERÍA COMMUNITY

What was the effect of climate warming?: *The community of Ovejería (rainfed hillside grain cultivation), was practically abandoned. Almost everyone moved away, leaving only a few old people. The main reason is that over recent years wheat and barley production fell so much that families could not feed themselves properly. The climate is very dry in this community*.

Where were these people?: *Most of the younger people left for the city, while others went to work as laborers in Rio Chico where crops are grown under irrigation*.

How do the remaining members of the old community live?: *In the community of Ovejería there are only a few goats left, being looked after by elderly people. Many years ago, when there was more grass in this community we raised sheep. Around 20 years ago we began to lose the sheep and started raising goats instead.*

(Interview with Marcial Vargas, agronomist)

In the Valleys goats were reported to have begun to replace sheep, which require more and better quality forage.

> *When I was young we had lots of animals at home—around 200 sheep and goats. Now have only 40. The problem is that animals have been dying from external parasites and disease. Previously we also had these problems but the animals were stronger and more resistant in those days, as well as bigger and fatter.* (Leonardo Ibarra, La Sillada)

An example of abrupt change due to warming concerns crops (grains) grown on the valley slopes. As the result of higher temperatures and water shortages average yields were reported to have fallen. The decline in production was so great that some families decided to give up and leave their land. In the Pueblo Abajo community (Sicaya, Valleys region), for example, three of the five families interviewed were originally from other hillside communities and had been forced to leave because the climate was so dry that they were unable to harvest enough to live on.

SENSITIVITY OF LIVELIHOOD STRATEGIES TO CLIMATE CHANGE

The responses in our community workshops enabled us to draw up a list of livelihood strategies based on the

TABLE 24. SENSITIVITY OF LIVELIHOOD STRATEGIES TO DROUGHT

Sensitivity	*Livelihood strategy*	*Effect of drought*
High	Rainfed agriculture	Water stress causing yield reduction
	Livestock farming	Loss of vegetation, shrinking water supplies, causing food shortages, loss of productivity, death of livestock.
Average	Agricultural employment	Reduced job opportunities
	Irrigated agriculture	Reduced irrigation flow, reduced yields
	Intensive livestock	Higher cost of fodder, water shortages
	Agriculture-related services and commerce	Decrease in incomes due to reduced agricultural production
	Forestry	Reduced density of exploitable species
Low	Agricultural employment	Fewer jobs
	Services and non-agricultural trade	Less activity due to reduced incomes of customers.

TABLE 25. SENSITIVITY OF LIVELIHOOD STRATEGIES TO FLOODING

Sensitivity	*Livelihood strategy*	*Effect of flooding*
High	Rainfed and irrigated agriculture	Floods cause loss of the harvest and depending on their intensity, loss of soil cover.
	Intensive and extensive livestock raising	Loss or deterioration of infrastructure Loss of livestock and decreased productivity
	Forestry	Displacement, reduced density of exploitable species.
Average	Services and agriculture-related trade	Demand reduction
Low	Agricultural and non-farm employment	Fewer jobs
	Services and non-agricultural trades	Demand reduction

Source: Community Workshop Enquiry Form 03.06

respondents´ level of sensitivity to the twin problems of drought and flooding, which according to the communities, are the most likely manifestations of climate change in the future.

In summary, in the opinion of the campesinos, all livelihoods will be affected to one degree or another by climate change—some of them less affected, some more. Livelihood strategies that are most likely to suffer are those that are directly dependent on climatic conditions such as rainfed agriculture, rainfed livestock raising, and forestry. Strategies which combine these farming activities with others such as non-agricultural jobs, trades, and service supply will probably be less affected.

The strategies less vulnerable to climate change tend to be those that are not based on agriculture. For families with non-agriculture strategies (wage earners, traders, and those with jobs in the transport sector) their activities will marginally affected, but any shortfalls can probably be easily met in other ways. In the case of wage-earning employees, their salaries are unlikely to be affected, but their purchasing power could well be reduced on account of generalized price increases caused by drought.

8. ADAPTATION TO CLIMATE CHANGE

LESSONS FROM THE PAST

The following paragraphs are an account of the responses given in family interviews regarding climate change. These serve as a basis for formulating practical and concrete adaptation measures.

Responses to extreme weather events

The study focused on the responses of the 70 families interviewed to past climatic events. Families were questioned, for example, on what action they took in the event of drought, hailstorms, frost, or flooding.

Fifty percent of the families surveyed claimed that in such circumstances they maintained their same life patterns but tended to cut down consumption and draw on their reserves. Among these families were (i) those not significantly affected by the climate event and (ii) those who were unable to react to the event. The former were generally the "richest" families, possessing plenty of good irrigated land and a level of agricultural production which would help them to survive. They were also invariably the families who had access, apart from farming, to other activities that were not totally dependent on climate change, such as outside jobs, trade, and processing value-added items for sale.

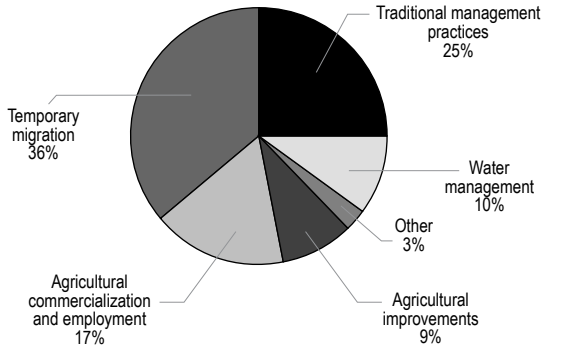
The second category were generally the poorest in the community, comprising elderly people, single women, etc., with scarce resources and who often were either unable to work or prevented from migrating or seeking a new economic activity. These people were apt to endure the hardship resulting from adverse weather events thanks to help received from neighbors and other family members. The following statements are examples of how extreme events affect the poorest families in the communities.

The case of Juana´s family (37 years old): *My main occupation is supplying milk. I have a number of cows and also go from house to house collecting milk for selling to the dairy. During the drought milk production fell by half because of the lack of forage. We had to manage on a reduced income. I have no husband, my children are too small to work and I was not in a position to leave my home.* (Juana Mamani, Jasi Pampa Community, Pucarani Municipality, Altiplano)

The case of Evaristo´s family (68 years old): *We live off rice, maize and cassava production (3 hectares), and the vegetables grown by my wife. We could do nothing when the drought came and simply waited for the next year in order to start again. Luckily we survived on vegetables which we were able to irrigate with the little water available to us.* (Evaristo Flores, San Isidro Community, Yapacaní Municipality)

The other 50 percent of respondents claimed that they took some form of action in the face of adverse climatic events. The responses were varied: Some claimed to have adopted new economic activities as part of their livelihood strategies, some decided to migrate to other areas, while others devoted themselves to improving their traditional farming methods.

FIGURE 20. RESPONSES TO CLIMATE HAZARDS



Of the 36 per cent of families who resorted to temporary migration, these were generally families who in normal circumstances would not migrate but who were obliged to do so in order to offset losses[12]. In emergencies such as prolonged drought, temporary migration generally involved people heading for the cities rather than to the traditional farming areas, which were also likely to be affected by drought.

Most respondents viewed migration as their preferred temporary measure for the following reasons:

- fewer mouths to feed in the community;
- the possibility of earning sufficient cash to cover urgent needs;
- opportunities to secure enough to avoid selling animals or divesting other capital assets for the duration of the emergency.

> The case of the Victor´s family (35 years): *We grow mainly bananas, rice, maize, and cassava. Our main problem during last year's flood was to find a place to shelter. We had to get rid of animals and find some other way of earning a living in the neighboring city of Riberalta. My whole family went. For three or four months I worked as a building laborer. It was not like that in the old days.* (Victor Yanam, Valparaiso Community, San Pedro Municipality)

Regarding the approximately 17 percent of the remainder who developed new activities such as making handicrafts, getting a local paid job, setting up a small business, or who migrated temporarily, the result was that over half the community was forced to find some form of new activity in order to offset further losses caused by climate hazard.

The other 50 percent of the families made an effort to incorporate improvements in their traditional occupations by installing irrigation, developing more productive farming techniques, improving infrastructure, or simply by selling their animals or using up their savings.

> Simon´s case (58 years): *We raise llamas and sheep and also grow a few crops on our small plots. During the last drought I had to leave home in order to seek work in the mining town of Porco while I left my wife and my children to care for the animals. We also had to sell some of the animals to have enough money to buy food. Our children who live in the city also helped us out a bi, by sending money home.* (Simón Choque, Chaquilla Community, Porco Municipality)

Meanwhile, around 25 percent of all the families and the community resorted to traditional rituals in cases of emergency such as praying for rain, building fires against frost, sending up fireworks against hailstorms, etc.

Autonomous changes in production systems

The climatic changes occurring in communities—identified primarily as higher temperatures, lower rainfall and recurring floods—are not a recent phenomenon but have come about gradually over several years, accompanied by gradual and spontaneous (unplanned) adaptation to production systems. These autonomous changes were identified and analyzed in the community workshops and provided the basis for the formulation of adaptation measures. The main trends were the following:

- installing irrigation
- changing varieties and species of crops

12 Morales et al. *Estrategias campesinas para enfrentar la sequía*, page 98

- changing to different breeds of animals
- changing animal husbandry systems
- converting pasture into crop land
- abandoning land
- undertaking a variety of different economic activities ("pluriactivity")
- protecting infrastructure
- relocating homes.

Table 26 provides a detailed description of the main changes identified in the communities.

It is worth noting that these changes occurred with no support from the state or other institutions, and came about at the initiative (and cost) of the families themselves in an empirical manner without previous planning. In common with any innovation in all rural communities, this process took place over a number of years, based on the "trial and error method," where new ideas are incorporated and consolidated only after they have been proven to produce good results. Municipal governments and institutions, at the request of communities, have been persuaded to use some of these ideas to execute irrigation and infrastructure protection projects (implemented in five of the communities studied).

At the participatory design stage of climate change adaptation measures, communities were fully aware of the above trends and initiatives but were also prepared to incorporate other measures based on information acquired as a result of the experiences of neighboring communities.

ADAPTATION MEASURES

As explained in Chapter 1 (Scope and Methodology of the study) we used Participatory Analysis for designing adaptation measures for the prioritized climate scenarios. The communities began by constructing future climate scenarios based on the analysis of change trends observed over the previous 20–30 years and on projections from general circulation models. An analysis was then done of the possible effects and impacts of climate change on family livelihood systems. Using their past experience, the communities were then able to identify possible measures for adapting to different climate scenarios. Each of the measures identified was discussed in community workshops and focus groups and subsequently subjected to a prioritization process.

The process of analysis and discussion in each community was undertaken with the support of technical staff trained to encourage forthright discussion without asking leading questions (i.e., inducing obvious responses from interviewees).

Classification of Adaptation Measures

A total of 134 adaptation measures was identified in the communities, with an average of nine measures per community. As will be seen below, these are highly concrete measures in line with the real situation of each community and genuinely reflect a particular community's real needs, the number of beneficiaries, local cultural criteria, previous experiences, etc.

With a view to identifying trends, these diverse and complex measures were divided into eight categories:

- Water management
- Infrastructure
- Livestock improvement
- Agriculture improvement
- Environmental management
- Advice and training
- Credit and financing
- Value added activities (processing) and employment

Water Management Measures

Water management measures basically consist of installing water storage infrastructure to facilitate water supply for human use. Three subcategories were identified:

1. *Use of existing water resources*: Building infrastructure (dams, etc.) to harness available water sources such as rivers, water catchment areas, and underground aquifers.
2. *Rainwater harvesting*: building infrastructure to capture and store rainwater, involving the construction of artificial reservoirs and *atajados* (small dams) and providing facilities for harvesting roof water.

TABLE 26. SPONTANEOUS CHANGES IN RESPONSE TO CLIMATE CHANGE

Measure	*Description*	*Stratum*	*Livelihood strategy*	*Macroregion*
Installation of irrigation	Construction of systems to exploit available water sources. Small-scale systems owing to the costs of the works involved and the limited availability of water sources.	"Rich" campesinos with capital	Strategies based on rainfed agriculture	Altiplano, valleys, plains
Changes of species and varieties of crops	Introduction of new shorter-cycle varieties and species resistant to drought, to allow later planting before the late rains and to earlier harvesting at the end of the shorter rainy season	All strata	Strategies based on rainfed agriculture	Altiplano, valleys
Changes in animal species and breeds	Introduction of breeds and species requiring less or lower quality fodder and which are more drought tolerant, such as goats and llamas, to replace sheep and alpacas	"Average" and "poor" campesinos	Strategies based on extensive livestock raising	Valleys (goats) Altiplano (llamas)
Changes in farming systems	In view of the gradual deterioration of grazing pastures a trend exists towards switching from extensive livestock raising to semi-stabled systems using cultivated forage and concentrated feeds (mainly for dairy and fatstock cattle).	"Rich" campesinos with capital	Strategies based on rainfed agriculture and extensive livestock raising	All macro-regions with communities near to cities
Grazing areas are converted into cropland	The 'bofedales' (permanently damp areas with grass cover in Altiplano communities), previously exclusively used for grazing, are converted into crop land due to the lower incidence of frost, dried up water sources and grass cover degradation.	All strata	Strategies based on extensive livestock raising	Altiplano, in communities that have humid 'bofedales'
Land abandonment	Abandonment of lands prone to drought, with little organic matter or which retain limited amounts of moisture; usually located on steep slopes and hills.	All strata, but mainly the "poor" campesinos working land that is more vulnerable to drought	Strategies based on rainfed agriculture	All macro-regions, mainly in the semi-tropical valleys
'Pluriactivity'	Incorporation of new activities in campesino livelihood strategies, in addition to the main activities. These include temporary migration, trades (bricklayer, blacksmith etc), and services provision (setting up a shop, selling food etc)	"Average" and "poor" campesinos	Strategies based on rainfed agriculture or livestock raising	All macro-regions
Infrastructure protection	Construction of flood control defenses against flooding and flash floods along the rivers.	"Rich" campesinos with capital resources	All	Flood-prone communities
Housing relocation	Relocating homes in places less exposed to flooding	"Rich" campesinos with capital resources	All	Plains

Source: Community workshops, family interviews

TABLE 27. EXAMPLES OF MEASURES FOR BEST USE OF EXISTING WATER RESOURCES

Macro-region	*Municipality*	*Community*	*Measure*
Chaco	Charagua	San Francisco	Micro-irrigation system construction and making use of river water
Altiplano	Carangas Curahuara	Uta Jila Manasaya	Drilling wells and installing hand pumps for drinking water
Valleys	Saipina	Oconi	Construction of a storage dam on the river Oconi
Valleys	Vitichi	Chapicollo	Underground storage tank[1]

1. This measure is in reality a very ancient traditional practice which consists of burying in the bed of the *quebradas* (small rivers which run only when it rains) a large tank for storing water. This resembles a swimming pool with a lid on it and is buried a few meters deep under the sand. The device has porous walls through which the water is captured and a small aperture at the top where water can be extracted with the use of buckets. The people in the communities recount that their ancestors always used this method but that the younger generation are not familiar with it.

TABLE 28. EXAMPLES OF RAINWATER HARVESTING

Macro-region	*Municipality*	*Community*	*Measure*
Altiplano	Carangas Curahuara	Uta Jila Manasaya	Construction of *atajados* for the irrigation of *bofedales*
Valleys	Tarvita	La Silla	Construction of 50 earth *atajados* with capacity of 4000c.m.

3. *Improvement and expansion of existing water systems:* infrastructure and equipment to expand water capture capacity and distribution systems with a view to avoiding future shortages. Improvement initiatives include training and the provision of facilities and equipment to make more efficient use of water such as pumping systems, improved piping layouts, and other efforts to prevent irrigation water losses.

Infrastructure Measures

Infrastructure measures include building infrastructure and providing defenses to protect against erosion or flooding, and ensuring that schools and homes are built in areas free from flooding.

Measures to Improve Livestock

These measures involve helping small farmers to introduce livestock that is more suitable to the impacts of climate change. Two subcategories can be identified:

1. *Changes to the livestock raising system*: infrastructure, training and equipment; introduction of new species and breeds better adapted to drought; and

TABLE 29. EXAMPLES OF IMPROVEMENT OR EXPANSION OF EXISTING SYSTEMS

Macro-region	*Municipality*	*Community*	*Measure*
Chaco	Charagua	San Francisco	Upgrading and expansion of drinking water system
Chaco	Villa Vaca Guzman	Aguayrenda	Repairs to tapping point, construction of holding tank and installation of pressurized irrigation
Plains	Yapacani	August 15	Emergency repairs to drinking water system and education center

TABLE 30. EXAMPLES OF INFRASTRUCTURE UPGRADING ADAPTATION MEASURES

Macro-region	*Municipality*	*Community*	*Prioritized action*
Plains	Yapacani	San Isidro	Construction of Condorito Bridge
Plains	Yapacani	San Isidro	Construction of social housing
Plains	Yapacani	August 15	Reconstruction of 5 km of the 15 de Agosto community´s main road
Plains	Yapacani	August 15	Construction of flood defenses along the River Yapacaní

TABLE 31. EXAMPLES OF MEASURES TO IMPROVE LIVESTOCK RAISING SYSTEMS

Macro-region	*Municipality*	*Community*	*Prioritized measure*
Altiplano	Pucarani	Pampajasi	Construction of dairy cattle infrastructure
Altiplano	Pucarani	Pampajasi	Upgrading dairy herds
Altiplano	Porco	Chaquilla	Construction of roofed folds and other infrastructure (forage racks, troughs, etc.).
Altiplano	Porco	Chaquilla	Comprehensive animal health program (de-worming of internal and external parasites, etc).
Altiplano	Porco	Chaquilla	Improving reproductive and genetic management (managed cross-breeding, selection and rotation of stud animals, avoiding use of underperforming animals).
Chaco	Villa Vaca Guzman	Aguayrenda	Management and recovery of native forest-deferred forage
Valleys	El Puente	Caña Cruz	Improving livestock infrastructure and introduction of goats for 25 families.

TABLE 32. EXAMPLES OF PASTURE MANAGEMENT MEASURES

Macro-region	*Municipality*	*Community*	*Prioritized measure*
Altiplano	Calacoto	Contorno Calacoto	Improvement of pastures and fodder
Altiplano	Porco	Chaquilla	Recovery practices in degraded wetlands (fencing, fertilization, irrigation and repopulation)
Altiplano	Carangas Curahuara	Uta Jila Manasaya	Improvement of native grasslands by constructing infiltration trenches (to aid runoff) and planting seeds of native grasses
Chaco	Villa Vaca Guzman	Aguayrenda	Management and recovery of native forest-deferred forage

construction of pens, stables and *apriscos* (cattle folds) as a prelude to shifting to semi-intensive farming.

2. *Grazing pasture management*: infrastructure and training aimed at the improvement, protection and management of grazing pastures; and preventing falls in load capacity due to climate change, including the establishment of regulatory frameworks limiting access to grassland.

Measures to Improve Agriculture

Measures to adapt agriculture to climate change can be divided into two subcategories:

TABLE 33. EXAMPLES OF CHANGED MEASURES FOR CROPPING SYSTEMS

Macro-region	*Municipality*	*Community*	*Prioritized measure*
Altiplano	Porco	Chaquilla	Organic farming, using selected native species and varieties tolerant to adverse weather conditions
Chaco	Charagua	San Francisco	Crops of early soft corn varieties, pearl maize, and beans in 22 Chaco family farms
Chaco	Villa Vaca Guzman	Aguayrenda	Protection of rice production
Chaco	Villa Vaca Guzman	Aguayrenda	Improved soil cultivation, hoeing, and selecting earlier and more profitable peanut varieties
Plains	San Ignacio	Puerto San Borja	Grain storage system (construction of silos)
Plains	San Pedro	Valparaiso	Fast-growing vegetable crops introduced
Plains	Yapacani	San Isidro	Control of high weed incidence in pastures and fruit orchards
Plains	Yapacani	San Isidro	Introduction of citrus trees in conjunction with coffee plants
Plains	Yapacani	Agosto 15	Diversification: citrus and cocoa planted
Plains	Yapacani	Agosto 15	Windbreaks installed in rice paddies
Valleys	El Puente	Caña Cruz	Construction of 50 family greenhouses.
Valleys	El Puente	Caña Cruz	Improved management of local varieties and introduction of new varieties of fruit trees (peaches) in 50 domestic orchards.

1. *Changing cropping systems*: infrastructure, equipment and training for introducing new species and adapted varieties; building storage facilities to ensure conservation of crops under warmer conditions.
2. *Farmland management*: infrastructure, equipment and training to ensure better soil management by seeking to improve water-holding capacity (in the event of drought); and installing drainage systems and controlling erosion (in the event of flooding).

Environmental Management Measures

Measures aimed at improving the management of forests and water catchment areas, together with regulation of access; and reforestation and revegetation to reduce water infiltration, erosion, flooding, and the drying up of water sources.

Training and Advisory Measures

Two subcategories of training and advisory measures exist to help people living in the communities better adapt to climate change:

1. *Manpower training:* to boost employment opportunities in the event of temporary or permanent migration.

TABLE 34. EXAMPLES OF AGRICULTURAL SOIL MANAGEMENT MEASURES

Macro-region	*Municipality*	*Community*	*Prioritized measure*
Altiplano	Porco	Chaquilla	Opening up and / or construction of drainage ditches to prevent crops being affected by permanent moisture.
Chaco	Charagua	San Francisco	Animal traction to aid arable land soil management
Chaco	Villa Vaca Guzman	Aguayrenda	Improved soil cultivation, hoeing and selecting earlier and more profitable peanut varieties.
Plains	San Ignacio	Puerto San Borja	Agricultural terracing (*lomas*) to prevent flooding
Valleys	El Puente	Caña Cruz	Management and recovery of soil fertility (0.5 ha / household)

TABLE 35. EXAMPLES OF ENVIRONMENTAL IMPROVEMENT ADAPTATION MEASURES

Macro-region	*Municipality*	*Community*	*Prioritized measure*
Chaco	Charagua	San Francisco	Forest management and recovery of native species
Valleys	El Puente	Caña Cruz	Reforestation and management training in woodland areas of 0.25 ha / household
Valleys	Saipina	Oconi	Reforestation to protect drinking water sources

TABLE 36. EXAMPLES OF MANPOWER TRAINING MEASURES

Macro-region	*Municipality*	*Community*	*Prioritized measure*
Altiplano	Calacoto	Contorno Calacoto	Technical training in various activities
Valleys	Tarvita	La Silla	Training for community leaders and young people
Valleys	Saipina	Oconi	Training courses for 40 families

TABLE 37. EXAMPLES OF MEASURES FOR TRAINING IN ALTERNATIVE OCCUPATIONS

Macro-region	*Municipality*	*Community*	*Prioritized measure*
Altiplano	Calacoto	Contorno Calacoto	Creation of Producers´ Association
Altiplano	Porco	Chaquilla	Training and user awareness for sustainable use of resources.
Plains	Yapacani	San Isidro	Diagnostic study on the timing of flowering of local plants
Valleys	El Puente	Caña Cruz	Production chain counseling program
Valleys	Saipina	Oconi	Exchange of experiences with other communities
Valleys	Sicaya	Pueblo Abajo	Tracking and monitoring climate change in community

2. *Training for alternative occupations*: training and advice given on seeking and undertaking new income-generating occupations in the communities, support for organizational strengthening.

Credit and Financing Measures

Measures of access to credit and financing aimed at supporting family adaptation initiatives.

Measures to Improve Employment and Value-added Activities

These include constructing infrastructure and introducing equipment and training with the aim of generating new sources of income to complement that earned from farming activities, together with measures to support organizational strengthening and associated marketing methods.

TABLE 38. EXAMPLE OF A CREDIT AND FINANCING ADAPTATION MEASURE

Macro-region	*Municipality*	*Community*	*Prioritized measure*
Altiplano	Calacoto	Contorno Calacoto	Management of low-interest loan financing

TABLE 39. EXAMPLES OF MEASURES TO IMPROVE EMPLOYMENT AND VALUE-ADDED ACTIVITIES

Macro-region	*Municipality*	*Community*	*Prioritized measures*
Altiplano	Calacoto	Contorno Calacoto	Processing and marketing of local products
Altiplano	Pucarani	Pampajasi	Support for the establishment of an organization to market aggregates (sand and stone)
Plains	San Pedro	Valparaiso	Community flat boat for transporting produce to market
Plains	Yapacani	San Isidro	Pilot center for improving apiculture techniques
Valleys	El Puente	Caña Cruz	Joint marketing of vegetables and traditional products
Valleys	El Puente	Caña Cruz	Production of lambswool fabrics by 10 families
Valleys	Vitichi	Chapicollo	Facilities installed for weaving and clothes manufacture
Valleys	Vitichi	Chapicollo	Establishment of tannery

FREQUENCY OF ADAPTATION MEASURES

Our analysis of the number of times each type of measure was included in community adaptation strategies indicates a number of interesting trends.

The above table indicates that on average each community included 8.9 adaptation measures in their livelihood strategies. The community with the largest number of measures was Chapicollo (Vitichi Municipality) with 17 measures, while Jila Manasaya Uta (Curawara Carangas Municipality) suggested only 5 measures (the lowest).

Water management was given the highest priority in community strategies (an average of 3.1 per community) followed by measures to improve agriculture and livestock raising.

Communities in the Altiplano and inter-Andean valleys (i.e., in the Andes) prioritized water management measures given that their main concern was drought. In the plains region and the Chaco, water management measures took second place to measures for improving agriculture. Livestock improvement was the main concern of the highland communities surveyed.

TABLE 40. AVERAGE NUMBER OF COMMUNITY ADAPTATION MEASURES BY MACRO-REGION

Measure	*Altiplano*	*Chaco*	*Plains*	*Valleys*	*Total*
Water management	3.0	3.0	1.8	4.2	3.1
Infrastructure	0.3	0.0	1.0	0.2	0.4
Livestock improvement	2.8	0.5	0.5	1.2	1.3
Agriculture improvement	1.5	4.0	2.3	2.8	2.5
Environmental management	0.0	0.5	0.0	0.4	0.2
Training and advice	1.3	0.0	0.3	1.0	0.7
Financing and credit	0.3	0.0	0.0	0.0	0.1
Employment and value-added activities	0.5	0.0	0.5	1.2	0.7
Total	9.5	8.0	6.3	11.0	8.9

TABLE 41. NUMBER OF PRIORITIZED MEASURES BY TYPE AND COMMUNITY

		Type of measure								
Macro-region	*Community*	*Water management*	*Infrastructure*	*Livestock Improvement*	*Improvement of agriculture*	*Environmental management*	*Training and advice*	*Financing and credit*	*Employment and value-added activities*	*Total measures*
Altiplano	Chaquilla	3		4	3		3			13
	Contorno Calacoto	2	1	3	1		2	1	1	11
	Uta Jila Manasaya	4		1						5
	Pampajasi	3		3	2				1	9
Total Altiplano		12	1	11	6		5	1	2	38
Chaco	Aguayrenda	4		1	5					10
	San Francisco	2			3	1				6
Total Chaco		6		1	8	1				16
Plains	Agosto 15	1	2		3					6
	Puerto San Borja	2		1	3					6
	San Isidro	1	2	1	2		1		1	8
	Valparaiso	3			1				1	5
Total Plains		7	4	2	9		1		2	25
Valleys	Caña Cruz	1		3	6	1	1		2	14
	Chapicollo	8		3	2				4	17
	La Silla	5			1		1			7
	Oconi	3	1		3	1	2			10
	Pueblo Abajo	4			2		1			7
Total Valleys		21	1	6	14	2	5		6	55
Grand Total		46	6	20	37	3	11	1	10	134

ADAPTATION STRATEGIES

Our results indicate that communities do not award priority to any single measure or to measures in isolation but combine different measures ("adaptation strategies") in order of priority, to be implemented within a specific time limit.

Strategies differ greatly. Communities located in the same macro-region with similar climate problems prioritized different strategies. For example, while all the communities in the Valleys region forecast drought as their predominant climate scenario, the measures and adaptation strategies to deal with drought vary. These differences are apparent not only in the total number of measures recorded but also with regard to the type of measures proposed and their order of priority. The following chart displays all the adaptation measures identified by the communities in the order of priority which communities assigned to them.

The above tables indicate a wide variety of community livelihood strategies which can be explained as follows. Firstly, each strategy tends to reflect the specific concerns of an individual community, especially regarding the extent to which it is exposed to, and aware of, climate change and its likely effects on the life of the community. The measures that have been identified and the priorities assigned to them also mirror the kind of measures or investments that have already been made (or not) in the community in the past. In effect the strategies depend on the recent history of a particular community. Communities, for example, that have succeeded in resolving the problems of drinking water supply thanks to investments already made considered that there was no need to include this measure in their livelihood strategy unless the current system was considered inadequate.

A further factor distinguishing the different adaptation strategies in the communities is the presence of institutions, or lack of them. We found during the study that the number and type of "institutional" interventions in a particular community impacted on the priority assigned to the measures by the communities. For example, the San Pedro Community (Plains), which hitherto had received little institutional support, awarded priority to measures which required only limited institutional help. On the other hand communities such as Saipina (Valleys), which currently benefit from significant investments made by the local authorities and private institutions, prioritized investments requiring substantial external support (see Table below).

General Trends

Analyzing this group of multifaceted strategies it is possible to identify general trends which are common to all the strategies and which present lessons for designing policies in support of climate adaptation.

A notable trend is that the prioritized measures related to a particular strategy effectively complement one another (i.e. they are not isolated, one-off, actions). Implementing a measure implies the need to undertake a series of other measures that complement and ensure that the desired end-results are achieved.

The case of the Contorno Calacoto community (Altiplano)

This community, located on the central Bolivian high plateau a few hours from the capital La Paz, is characterized by its extreme poverty owing to very low agricultural production. Agricultural production has deteriorated significantly as a result of climate change, with water scarcity one of the community's major problems.

Contorno Calacoto´s first priority is to introduce measures related to water supply for human consumption and farming activities. Secondly, the community has assigned priority to improving livestock rearing through two measures: improving pasture and fodder—the main limiting factors owing to deterioration of the grasslands over the past few years.

The community also hopes to develop semi-stabled livestock rearing and therefore requires stables and covered pens to be built. This implies completely transforming the livestock rearing system by switching beef production to dairy production. This will obviously imply families investing more money and time. A related but a lower priority strategy would be to seek genetic improvements for the beef herd.

The community also foresees improving its farming techniques by introducing seeds which are more

TABLE 42. VALLEYS: PRIORITIZED ADAPTATION MEASURES, BY COMMUNITY

	Chapicollo (Vitichi)	*Caña Cruz (El Puente)*	*Oconi (Saipina)*	*Pueblo Abajo (Sicaya)*	*La Silla (Tarvita)*
1	Micro-gravity dam	Construction of 5 *atajados* and 15 tanks, with appropriate piping systems	Construction of water storage dam on the River Oconi	Lining irrigation canal of the Palermo I cooperative	Construction of a 100,000 c.m. dam
2	Construction of *atajados* (small dams) with 3000 m^3 capacity	Management and recovery of soil fertility: 0.5 ha / household	Construction of 40 domestic *atajados*	Improving inter-community irrigation channel	Construction of 50 *atajados* with 4000 c.m. capacity
3	Construction of *atajados* with 5000 m^3 capacity	Production chain counseling program	Acquisition by the community of a farm tractor with attachments	Construction of *atajados* and rainwater management	Construction of 6 micro-irrigation systems
4	Construction of irrigation infrastructure (distribution system)	Construction of 50 family greenhouses.	Reforestation and protection of drinking water sources	Construction of wall	Construction and improvement of irrigation channels
5	Establishment and regeneration of native forage species.	Improvement of livestock infrastructure and introduction of goats for 25 families.	Provision of certified seed potatoes for 40 families in Oconi	Technical assistance for integrated crop management practices involving permanent adaptation to climate change	Silos for storage of 1000 'quintales' of native seed
6	Reinforced concrete domestic *aljibe* (water tank)	Improved techniques and varieties of traditional crops and vegetables in 50 orchards	Provision of hybrid tomato seeds for 40 families in Oconi	Community tracking and monitoring of climate change	Leadership training
7	Well-drilling (first stage)	Improved management of local varieties and introduction of new varieties of fruit trees in 50 orchards.	Project for Integrated Pest Management of potato and tomato cultivation for 40 families in Oconi	Micro-irrigation systems in rainfed areas for families and for sharing between families	Installation of sprinkler irrigation
8	Improved livestock folds	Marketing vegetables and traditional products jointly.	Implementation of custard apple (chirimoya) production project using micro- irrigation		
9	Drilling – submersible pump (second phase)	Small tools needed to manage agricultural land for 50 families.	Training Courses for 40 families in Oconi		
10	Fenced areas for regeneration of forage species, improvement of shelters, breeds, provision of equipment	Animal Health Improvement.	Exchange of experiences with other communities		
11	Underground water cistern	Reforestation and management training in woodland plots of 0.25 ha / household.			
12	Motorized farm equipment and tools.	Production of woolens by 10 families.			
13	Facilities for weaving and sewing	Improved breeds of goats.			
14	Dairy Production Centre	Plant health surveillance program in fruit orchards.			
15	Establishment of tannery				
16	Silos, supply bases (*pirhuas*) and seeds				
17	Production, planting of peaches and installation of mesh to protect from hailstorms.				

TABLE 43. PLAINS: PRIORITIZED ADAPTATION MEASURES, BY COMMUNITY

	San Isidro (Yapacani)	*Puerto San Borja (San Ignacio)*	*Agosto 15 (Yapacani)*	*Valparaiso (San Pedro)*
1	Water supply system for cattle	Construction of water hole (*aguada*)	Emergency water recovery and Educational Center	Community flat boat to transport produce to market.
2	Construction of social housing	Family plots to be fenced off	Construction of defenses on the River Yapacaní	To plant fast-growing vegetables.
3	Improved dual-purpose cattle	Grain storage system	Repair of 5 km of main road in the Agosto 15 community	Domestic irrigation using waterwheels in orchards
4	Construction of the Condorito Bridge	Irrigation pumps to be installed	Installing windbreaks in rice paddies	30 irrigation pumps for irrigating family orchards in the Valparaiso community (with river water)
5	Pilot centre for apiculture improvement	Construction of artificial terracing	Restarting rice production in the Agosto 15 community	10 irrigation pumps for lifting river water to irrigate family vegetable plots
6	Controlling high incidence of weeds in pastures and orchards	Construction of furrow terracing (*camellones*)	To diversify agricultural production by planting citrus and cocoa	
7	Joint production of citrus and coffee			
8	Diagnostic study on flowering times of local plants			

TABLE 44. CHACO: PRIORITIZED ADAPTATION MEASURES, BY COMMUNITY

	Aguayrenda (Villa Vaca Guzman)	*San Francisco (Charagua)*
1	Repair and expansion of community water system	Improvement and expansion of drinking water system
2	Repair of water tapping inlet, construction of storage tank and installation of pressurized irrigation	Early crops of soft corn, pearl maize and beans in 22 family plots
3	Better soil cultivation, hoeing, selection of early peanut varieties at better prices	Improvement and protection of 2 ha family plots for growing combined crops
4	Protection of cultivated areas	Construction of micro-irrigation system to make best use of river water
5	Construction of a reservoir and relevant infrastructure to improve irrigation	Animal traction for soil management and conservation of arable land
6	Selection of early-yield drought resistant rice seed	Forest management and rehabilitation of native species
7	Protection of rice paddies	
8	Management and recovery of native forest using rotation methods	
9	Soil management of plots in protected areas	
10	Combining fruit and vegetable cultivation	

resistant to drought, requesting technical support and training to help with this changeover.

Finally the community awards priority to measures for strengthening its own organization and training and will need to seek financial help for underpinning value-added economic activities to complement farming production. It can be observed from all this that the community is considering a radical transformation of its livelihood strategies as a necessary step toward adapting to climate change.

A second key trend noted is that the order of implementation is vitally important. Prioritized actions cannot be

TABLE 45. ALTIPLANO: PRIORITIZED ADAPTATION MEASURES, BY COMMUNITY

	Chaquilla (Porco)	*Contorno Calacoto (Calacoto)*	*Pampajasi (Pucarani)*	*Jila Manasaya Uta (Curawara Carangas)*
1	Improved water irrigation management systems to streamline water use and reduce silting	Construction of wells and water catchment facilities	Construction of a dam	Construction of multifamily water system
2	Construction of new irrigation channels to include water tapping facilities and water flow chambers for efficient irrigation.	Construction of reservoirs	Construction of reservoirs	Drilling wells and installing hand pumps for drinking water
3	Measures to recover degraded wetlands (fencing, fertilization, irrigation and replanting)	Improvement of pastures and fodder	Build infrastructure for dairy herd management	Improving family wells and installing hand pumps
4	Training and user awareness to enable sustainable use of available resources.	Livestock Infrastructure	Management and improvement of agricultural production	Improvement of native grasslands with the construction of infiltration trenches and planting native grass seeds
5	Construction of roofed livestock shelters and other necessary infrastructure to upgrade production	Support for farming activities	Management and conservation of fodder	Construction of *abajados* for irrigating wetlands *(bofedales)*
6	Comprehensive animal health program	Management of low-interest loan finance	Improvement of dairy herds	
7	To improve reproductive and genetic management.	Technical training in various activities	To support the establishment of a body to produce and sell aggregates	
8	Training and awareness among livestock raisers for the sustainable production and handling of animals.	To organize a Producers Association	Vegetable production in solar-heated enclosures	
9	Construction and / or repair of defenses and retaining walls in cultivated terraced plots.	Improvement of productive infrastructure	Handling and production of potato crops	
10	Improvement of irrigation canals and water tapping facilties for efficient use of irrigation water.	Management and livestock genetic improvement		
11	Opening and / or construction of drainage ditches to prevent moisture damage to crops.	Processing and marketing of local products		
12	Organic farming using selected native species and varieties tolerant to adverse weather conditions.			
13	Training and awareness-raising of community residents to protect and preserve soils used for growing crops			

Source: Community Workshops

undertaken haphazardly because most measures require others to be implemented first in order to generate the appropriate conditions for further action.

As noted above, residents of the Contorno Calacoto community are planning key changes to their livestock rearing system by introducing semi-stabled cattle. The steps to be taken are therefore: (i) to guarantee a good supply of water; (ii) to improve grasslands and fodder; (iii) to move ahead with livestock infrastructure construction once the feeding situation is resolved; (iv) to strengthen community organization; and finally, once all the minimum technical conditions are in place, (v) to introduce genetic improvements for the livestock. It is considered that unless the measures can be undertaken in this order the adaptation exercise would fail.

TABLE 46. ADAPTATION STRATEGY OF THE CONTORNO CALACOTO COMMUNITY

Priority	*Measure*
1	Construction of wells and water capture facilities
2	Construction of reservoirs (water capture)
3	Improvement of pasture and forage
4	Livestock infrastructure (pens, stables)
5	Support for agricultural activities (seeds,TA and training)
6	Low interest financing management
7	Technical training in different activities
8	To organize a Producers´Association
9	To improve productive infrastructure (soil management)
10	Handling and genetic improvement for cattle
11	Processing and marketing of local products

A third trend is that the strategies are comprehensive and not confined to investments in infrastructure. These strategies include, apart from installing the correct infrastructure (perhaps the costliest step), training, advisory and organizational support measures.

Finally, a fourth trend is that water management measures generally have top priority. In 14 of the 15 communities surveyed, measures to deal with water management are prioritized. On the other hand, throughout the study we were able to identify 46 water management measures, and it is noteworthy that in 38 cases (83 percent) such measures were put forward as being among the top three priorities of the communities. Table 47 below confirms that water management is the foremost measure needed for adapting to climate change.

Adaptation Strategies for Drought

Adaptation to drought, especially by improving water management, involves a switch from rainfed farming to irrigated systems. This is a major change with important implications.

Firstly, installing an irrigation system involves constructing an appropriate infrastructure and training users in its operation and maintenance. Communities have proposed various types of infrastructure. The most noteworthy case is probably that of Chapicollo (Vitichi Municipality, Valleys) whose adaptation strategy embraces 16 measures of which eight concern water management employing different types of infrastructure. The community proposes, for example, the construction of a dam to supply a small part of the land located in the bottom of a valley. For land on the slopes it is proposed to construct two types of *atajados* (large and small dams/reservoirs). Meanwhile, in order to resolve the drinking water issue various measures have been advanced to serve this dispersed community: well drilling, construction of systems for housing rainwater, building underground cisterns, etc.

TABLE 47. ORDER OF PRIORITY FOR ADAPTATION MEASURES

	Order of priority																
Type of measure	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*Grand Total*
Water management	14	9	5	5	3	1	3	3		3							46
Infrastructure		2	2	1					1								6
Livestock Improvement			4	2	5	2	2	1	1	2			1				20
Improvement of agriculture		4	3	5	6	6	4		4		1	1		1	1	1	37
Environmental Management				1		1					1						3
Training and advice			1	1		2	1	3	1	1			1				11
Financing and credit						1											1
Employment and value-added activities	1				1		1	1			2	2	1	1			10
Grand Total	15	15	15	15	15	13	11	8	7	6	4	3	3	2	1	1	134

The community of Pueblo Abajo (Sicaya, Valleys), identifies three water management measures:

- expanding the coverage and capacity of the existing water system;
- building *atajados* for harvesting rain; and
- building an irrigation system to take advantage of an existing water source.

Secondly, irrigated agriculture involves changing entire farming or animal breeding systems. Introduction of irrigated agriculture involves for example:

- new types of agricultural equipment and tools. Communities where irrigation is being introduced for the first time (e.g., Caña Cruz and El Puente) require assistance for purchasing tools;
- growing different crops and introducing new species and varieties require technical training and a supply of genetic material (e.g., the Oconi community approach);
- upgrading conservation and storage systems for the new crops. (e.g., La Sillada community).

Another common response to the need for coping with drought is to change the livestock rearing system by switching from an extensive system to a controlled semi-stabled system, inevitably involving substantial disruption for families and communities.

Such a response also involves upgrading the management of grassland and woodland grazing, replacing free and unrestricted access with a controlled and regulated system. Controlled grazing means that families will need to devote more time to raising their cattle. Rearing livestock will therefore need to be a more productive activity (to justify the increase in labor), which in turn involves improving animal health and reproduction, especially through the use of genetics to upgrade the stock.

The proposed changes to cropping systems can be clearly observed in the livelihood strategies of Contorno Calacoto, Chaquilla, Porco, Caña Cruz, and El Puente.

A further approach is to introduce improvements without the need for irrigation. This is particularly the case in communities on the plains where rainfall is high and where crops are not as prone to drought. These communities, such as San Isidro and Agosto 15, propose introducing new species and varieties which require less water and which can withstand higher temperatures.

Finally, secondary (lowest priority) measures concern changing production techniques, introducing technical training and examining ways of generating supplementary income from different sources. Chapicollo, Caña Cruz, and Oconi, for example, argue that tanning, cloth-making, and dairy production fall into this category, while Contorno Calacoto and Pampajasi mention moving into the processing and marketing of aggregates.

Adaptation Strategies for Flooding

Only three communities in our sample (Agosto 15, Valparaiso, and Puerto San Borja) claimed that climate change would cause increased flooding in their areas.

Key actions proposed by these communities include infrastructure works and acquiring new equipment. Puerto San Borja proposes constructing artificial terraces (*camellones*) and hillocks (*lomas*) to avoid losing crops and livestock at flood times, and fencing off agricultural plots on higher ground to prevent animals seeking refuge in them during floods.

Agosto 15 proposes rebuilding the educational center in a more protected location, building a flood defense system on the banks of the river, and reconstructing a stretch of road in a place less susceptible to flooding.

Valparaiso, which has received the least institutional intervention, proposes purchasing a community boat to help relocate families in the event of flooding. The community also maintains that it will introduce annual crops such as vegetables and other species that can be harvested before the beginning of the flood season.

NON-PRIORITIZED MEASURES

A number of "spontaneous" measures used in the past were not included in the adaptation strategies:

1. *Seasonal migration*: a common practice in rural communities, even without climate change, but in

drought or flood scenarios temporary migration has become a kind of Plan B, which comes into play when other adaptation measures fail to work (e.g., insufficient irrigation).

2. *Land abandonment*: also a common practice for families who cease farming land, because it has become too exposed to drought or flooding, and relocate to other areas. Entire communities have been known to move to areas further away. This practice, however, tends to be costly, involving rebuilding the social infrastructure, housing, roads, etc. In certain circumstances this will effectively be a Plan B to which people resort when other adaptation measures fail or are beyond the community's resources.

   As with temporary migration, abandoning the land forms part of the stock of campesino responses to climate hazards. However, land abandonment was not prioritized in our study as an adaptation measure given that the logic applied to identifying adaptation measures was on the lines of: "What should we do to adapt and not have to abandon the community."

   > *We do not want to move the community. This would be an easy way out for the authorities. We want to stay in our community despite flooding. It took a lot of effort to build our community here and it is now a strategic place, a port where everybody goes through. We need help to stay in our own place and not to get us to move.* (Aydee Jimenez, Beni)

3. *Water catchment basin management*: was not mentioned frequently in the course of the study. Passing reference was made to it in discussions about the management of grasslands and forests and environmental recovery. Nevertheless, when referring to the causes and effects of climate change, communities argued that excessive deforestation was the main cause of erosion and shortage of rain.
   Catchment area management usually involves several communities. The measure was not included in community adaptation measures because its inclusion would have required the concurrence of all the communities located within the basin concerned (the study methodology addressed individual communities rather than entire groups of communities located in river basins).
   Catchment basin management will undoubtedly be given priority both in the flood and drought scenarios since this adaptation measure tends to increase tree cover in the specific area of the basin, control erosion, reduce water runoff, and increase the infiltration to feed the underground streams and reduce swollen rivers during flood periods.

PERCEPTION OF LOCAL AUTHORITIES ABOUT CLIMATE CHANGE ADAPTATION

Climate Change

Our interviews revealed that all the municipal authorities had heard of climate change but not all of them had particularly accurate knowledge. They all claimed that this was a matter of concern that could have a negative effect on the development of their municipalities. Most of the local authorities believe that climate change is a "thing of the future."

In the majority of municipalities[14] (11 cases out of 14) the authorities saw climate change as a problem for the future and with little current impact. In the 11 municipalities, six were unable to identify clear changing trends in temperatures or rainfall and appeared more concerned with climate variability and "El Niño" phenomenon. Officials in the five remaining municipal authorities agreed that temperatures were higher than

TABLE 48. LOCAL AUTHORITY PERCEPTIONS OF THE TIMING OF CLIMATE CHANGE

	Municipalities
Climate change is something in the future	11
Climate change is with us now	3

Source: Interview with local authorities

14 No clear trend can be detected on a per macro-region level. This number (11) includes municipalities from all the macro-regions. The most evident trend is that these are the municipalities where the climatic scenarios mainly concern drought.

previously, but they made no reference to the fact that this had negative effects on agriculture or on the lives of the communities, apparently believing that the effects and impacts of climate change were something to be tackled at a future date.

Local authorities in only three of the 14 municipalities in our sample agreed that climate change had already commenced, since their municipalities had been affected by heavy flooding. It was noted, however, that official views were not unanimous: two of the municipalities averred that the floods were directly caused by El Niño and that climate change had caused this phenomenon to be more frequent and intense than previously. In all three cases it was considered that climate change was already affecting Bolivia, but that these effects had only become apparent over the last 10 years.

It can be argued that a difference exists between the campesino viewpoint and that of the local authorities. People in the communities were adamant that climate change had started twenty or thirty years ago and was a continuing process, affecting their lives and livelihoods, while most of the authorities reckoned that climate change was a thing of the future and would come about suddenly (with the exception of officials in municipalities that had been affected by flooding, who considered that climate change began around 10 years ago).

Officials also differed from the campesinos in their attitudes towards the timing and effects of climate change, arguing that climate change would be catastrophic, would come about without warning and cause widespread tragedy. The campesinos on the other hand argued that climate change was a continuous, gradual process to which they could adapt. Explaining the official approach, Daniel Maydana, the Mayor of Curawara, told researchers:

> *In our community it would seem that over the last 10 years it has certainly got warmer and at critical times water is in short supply. But for the moment climate change is not a problem here and is not recognized as such in this municipality. It's true that there are natural disasters but these have always been common in our area and we have an annual budget of Bs35,000 to deal with this. No doubt in future there will be more disasters.*

Adaptation Measures Envisaged by Municipal Authorities

In the course of our study we were unable to identify any specific official climate change adaptation measures in any of the municipalities. No programs existed and no resources had been assigned to climate change. The municipal governments generally confined themselves to arguing that climate change was a new problem that was gradually being addressed.

In a number of municipalities concrete actions had been undertaken that could be interpreted as being related to climate change, but these related mainly to emergency assistance to deal with climatic hazards such as flooding and drought. The latter was provided in the form of food aid for people affected by drought and, in the case of flood victims, food and medical/healthcare assistance had been offered.

Municipal authorities have also been called upon to invest in repairing infrastructure damaged by flooding.

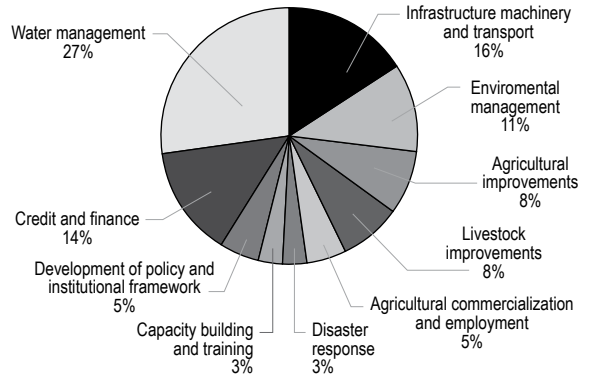
In one of the areas studied (Yapacaní), which was particularly vulnerable to flooding, it was mentioned that a specific risk management program had been established, consisting of an early warning system and educational outreach for the population to warn of the need to take precautions in the event of severe floods. This was a pilot project being taken forward jointly with private development institutions.

The bulk of municipal investments are focused on development work. This includes water management, agricultural and livestock improvement projects, etc., not explicitly linked to climate change.

Possible Municipal Interventions Related to Adaptation

When local authorities were asked how they could best support communities to adapt to climate change, the responses were given in imprecise and general terms, due no doubt to the fact that the issue is still relatively new on the local agenda. An analysis of the responses from the 14 municipalities indicates a number of interesting trends, with the authorities identifying 10 types of interventions, as displayed in the figure below.

FIGURE 21. POSSIBLE MUNICIPAL INVESTMENT IN ADAPTATION



Municipal authorities awarded priority to the construction of water management infrastructure (dams, *atajados*, potable water systems, etc.), followed in order of importance by financing for anti-flood defenses, housing, roads and bridges, environmental management, and agricultural/livestock improvement. Three percent of projected measures would target emergency relief.

Comparing the types of measures envisaged by the authorities with those prioritized by the communities it can be observed that, overall, both give priority to water, arguing that water management is the main climate adaptation measure to be taken. This is the only major point of agreement between the authorities and the communities.

As can be seen in Figure 22, the communities and the authorities gave significantly different priorities to the types of projects, except for water management. Communities give greater importance to investments related to "improving agriculture," "improving livestock rearing." "processing and marketing," and "advice and training." On the other hand, the local authorities place greater importance on "infrastructure building," regulating access to natural resources ("environmental management," regulatory frameworks, etc.) and emergency assistance. From this it is clear that climate adaptation from the viewpoint of the municipal authorities is mainly a question of investing in infrastructure works, while for the communities adaptation to climate change is principally a process targeted at transforming livelihood systems.

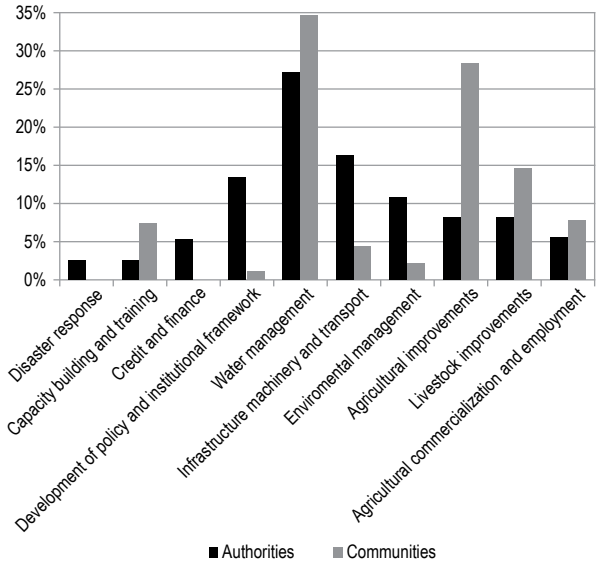
The communities, rather than awarding priority to one-off projects, have worked out complex strategies combining a range of investments (including training) needed to transform production systems based upon control of water resources.

Climate change is, however, a new issue for the municipal authorities and, regardless of community concerns, it is obvious that local authorities have not thought systematically and deeply about climate change—and even less about the measures needed to adapt to it. There can be no doubt that the official approach and the related investment strategies will change significantly once the authorities begin to regard climate change as a priority, and above all when they open discussions with the communities about the various adaptation measures required.

Support Needed by Local Governments

Local authorities were asked what support they required from the central government to deal with climate change. The main responses were as follows:

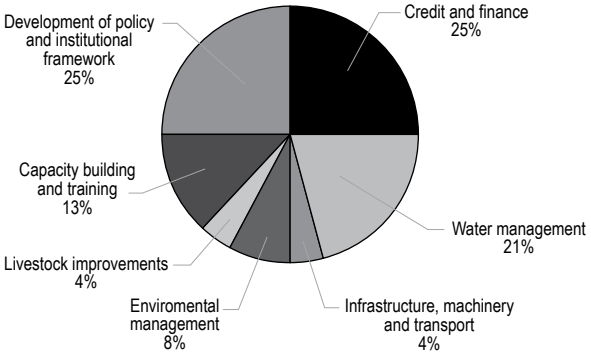
FIGURE 22. COMPARATIVE ANALYSIS OF ADAPTATION MEASURES



1. Development and implementation of national standards to curb environmental degradation, particularly deforestation and grassland burning;
2. Additional funding for municipal budgets, specifically for adaptation to climate change;
3. National and departmental irrigation projects to be undertaken;
4. Training and technical advice for municipal authorities and technical staff on climate change: causes, effects and possible impacts and the role of local government.

The above figure indicates that local municipal authorities clearly hope that Central Government will help them to develop the local capacities needed to address climate change.

FIGURE 23. SUPPORT REQUIRED FROM CENTRAL GOVERNMENT



9. SUMMARY AND CONCLUSIONS

CLIMATE CHANGE

Observation of the climate is a permanent practice in the communities.

Campesino and indigenous communities possess a long and rich tradition of systematically observing climate evolution, since their livelihoods depend upon it. The results of our study showed that communities generally have an accurate knowledge of changing climate trends over the long term.

However, the community workshops revealed that there was little capacity for forecasting shorter-term climate changes. Climate change and increased climate variability means that many of the traditional climate indicators are no longer effective, which obliges the communities to construct new indicators for predicting weather over the short term.

The powers of observation and interpretation of the climate possessed by people in the communities areimportant advantages which authorities should take into account when designing climate change policies.

The key climate change trends identified by the communities are rising temperatures and increased water scarcity.

One of the main conclusions of our study is that climate change has been observed in all communities, regardless of the particular ecosystem in which they are located. The most significant trends compared with 20–30 years ago were identified as: (i) rising temperatures and increased shortage of water; and (ii) increasingly irregular rainfall with shorter and more intense rainy seasons. The campesinos in Bolivia's Amazon region claimed that temperatures were higher, more rain fell than previously, and that floods were more frequent, more intense, and lasted longer.

The communities regard drought and floods as being the main problems in the climate scenario for the future.

Judging from the climate trends observed, the communities studied have come to the conclusion that the most probable future climate scenario will involve higher temperatures and water shortages affecting the country's four micro-regions, together with higher rainfall and extensive flooding in the Amazon.

CLIMATE CHANGE IMPACTS

Climate change Will Have negative effects on communities´ quality of life.

All communities came to the conclusion that climate change will have an immediate and direct effect: a sharp decline in production capacity, related to a reduction of soil, grassland, and forest-based productivity due mainly to insufficient water to offset the expected higher temperatures and consequent evapotranspiration. Reduced production is likely to mean economic hardship for many families who will have fewer surplus goods to sell.

In addition to impacting negatively on farming jobs, climate change will also lead to people eating poorer quality food and less of it. All the communities participating in the study without exception considered that hunger and increased disease would become an issue. They also drew attention to the negative effects of climate change on children's education.

The communities also believe that the climate change is likely to speed deterioration of the environment, especially the wooded areas and grazing pastures. In the case of the latter, it was claimed that pastures would be unable to provide grazing for the present number of animals, and the cost of upgrading pastures would be prohibitively high.

LIVELIHOOD STRATEGIES TO CLIMATE CHANGE

The livelihoods of the poorest are most vulnerable to climate change.

Identifying and categorizing family livelihood strategies, our researchers detected a wide range of livelihood strategies among families in the various communities. These strategies varied, depending on the opportunities and constraints existing in the immediately surrounding environment.

The study also found that there was a direct relationship between families´ livelihood strategies and their socio-economic strata, demonstrating that swapping one strategy for another depended not on freedom of choice but on the resources that families happened to possess.

The communities were given the opportunity to analyze the impacts of climate change, concluding that certain livelihood strategies were more vulnerable than others. The poorest families in the communities considered themselves to be the most vulnerable given that they were more exposed to the problems of climate change and had fewer means of responding.

Livelihood strategies based on rainfed agriculture and extensive livestock raising were considered to be the most vulnerable since they depended directly on the amount and timing of rainfall. The already precarious and poorly diversified nature of this kind of farming means that it is more exposed to risks.

The poorest families in the flood regions were judged to be less able to protect themselves (because of poor housing, lack of boats, etc.) from generalized flooding of entire communities.

It was also found that households headed by single women (with no males of working age), elderly people, or with male members unable to work, find it more difficult to cope with climatic hazards.

ADAPTATION MEASURES TO CLIMATE CHANGE

The communities formulated their adaptation measures to climate change on a participatory basis, based upon the prioritized climate scenarios. An average of nine adaptation measures was identified per community, with the following key features:

Strategies and Adaptation Measures

In their discussions on climate change the communities tended not to consider isolated measures or projects but rather to think in terms of a group of adaptation measures that could be prioritized together over time. They firmly believed that implementing adaptation "strategies" rather than "measures" should be the most important goal.

These strategies vary significantly from one community to another regardless of their belonging to the same ecosystem. We noted that strategies differed not only in the type of measures included but also in their order of priority.

The great variety of community adaptation strategies can be explained by the diversity of Bolivia in agro-ecological, cultural, social, and political terms. Community views on adaptation to climate change depend primarily on the communities´ level of exposure to climate change, the importance of the main lifestyle strategies in a particular community, available resources, and, finally, their experience with measures that have already been adopted in the past.

The Importance of Implementing Measures in Sequence

The communities believe that prioritized measures cannot be implemented haphazardly but must be carried

out in strict order of precedence. This is determined by the fact that certain actions require the prior execution of measures that create the appropriate conditions for further measures to be undertaken. Changing the logical order of implementation runs the risk of not achieving the desired results. For example new breeds of animals should be introduced only after the question of how to feed the animals has been resolved, not vice versa.

Adaptation is essentially a social process.

Furthermore, the communities argued that identification and implementation of adaptation strategies are not individual processes relating to a single family. On the contrary, the strategies require groups and communities to participate and collaborate in this task. Effectively the strategies are regarded as "social strategies." It follows that adaptation measures need to be analyzed, prioritized, and negotiated with the agreement of all members of the community. In the event major measures are needed (road construction, river basin management, etc.) negotiations should be undertaken jointly by various communities.

Adaptation involves major changes in life systems.

Communities believe that adaptation is not simply a question of investing in infrastructure but requires organizational development, training, and changes in living systems.

Adaptation strategies involve changes to production systems, such as switching from rainfed to irrigated systems, switching from free grazing to controlled grazing or from extensive to intensive livestock raising. Adoption of these new production systems involves not only changes of economic logic but also technological, organizational, and financial changes. With regard to the latter, close attention has to be paid to the amount of capital available for investing in family production units.

Water resource management as a basis for adaptation to climate change.

Adaptation strategies include measures to manage water resources during both droughts and floods. A substantial number of proposals have been put forward for managing water, all of them targeted at ensuring water supply of the right quality and quanity and at the right time. Good water management involves constructing new capture and storage infrastructure, improving distribution systems, and optimizing water usage. This range of proposals by the communities can be summed up as follows: (i) the importance of capturing rainwater in the Altiplano and Valleys, storing it, and making best use of it at times of the year when it is scarcest; and (ii) to reduce the effect of flooding in the lowlands. All this implies shifting from rainfed to irrigated farming practices.

Adaptation through grassland and forest management improvement.

All the communities identified that grazing pastures were likely to deteriorate as a result of climate change and that their capacity to feed animals would diminish. In order to avoid overloading pastureland (resulting in further deterioration of grassland) the campesinos were of the opinion that major changes needed to be made to the ways in which pastures and forests were managed, i.e., to regulate access and develop methods for regenerating the vegetation cover. This change implies a major change in livestock farming methods—from free range to controlled grazing and semi-stabling—as well as for campesinos to spend more time on their livestock-related activities in order to produce more profitable herds. This obviously implies introducing new breeds, installing proper shelters, training, etc.

Adaptation involving developing new complementary economic activities.

Communities agree that farming alone will not be sufficient to tackle climate change and that it is necessary to develop other, higher value-added activities producing goods that can be sold to generate higher returns, processing farm produce, and developing mining activities and trades, etc.—all of which generally involves investing in technical training and organizational support.

THE LOCAL INSTITUTIONAL FRAMEWORK

A favorable institutional framework for adaptation exists at local level.

The study revealed that all the municipalities private institutions (NGOs, producer associations, social organizations, and trade unions) over many years had fostered and supported development as an adjunct to the efforts of different levels of government.

At least half of such private institutions had sufficient operational capacity to become useful partners in formulating public policy initiatives aimed at adaptation to climate change.

THE VIEW OF LOCAL AUTHORITIES

A notable distinction exists between the views of communities and local authorities with regard to climate change.

The local officials interviewed believe that climate change is something that will come about in the future and that tackling it would involve a series of adaptation measures, especially infrastructure-building.

This approach differs substantially from that revealed in our interviews in the communities, where it is considered that climate change has been an accepted part of life for many years and that addressing it requires strategies to be developed—given that adaptation implies a fundamental change in livelihood strategies for communities, rather than being confined to one-off investments.

Local authorities require national government support for developing their capacity to adapt to climate change.

Local authority officials stressed that coordinated action between central and local governments was needed to adequately support adaptation measures. Local authorities argued that the following specific commitments from central government were required:

1. Development and implementation of national standards to curb environmental degradation, particularly deforestation and grassland burning;
2. Additional funding for municipal budgets targeted specifically at climate change adaptation;
3. Irrigation projects to be undertaken at the national and departmental levels;
4. Training and technical advice for municipal authorities and technical staff regarding the causes, effects, and possible impacts of climate change and an examination of the role of local government in addressing this problem.

10. RECOMMENDATIONS FOR DESIGNING POLICIES IN SUPPORT OF ADAPTATION

The following recommendations for formulating policies in support of adaptation to climate change are based upon the results of our study:

1. We recommend that Central Government, when defining public policies for adaptation to climate change, should value the experience of the campesino and indigenous communities. Adaptation to climate change is nothing new in these communities, where people have developed appropriate livelihood systems in keeping with a dynamic and ever-changing environment. The communities possess a veritable storehouse of strategies and a wide and valuable diversity of responses to the problems. We believe, therefore, that efforts to define national climate change policies should rise above purely technical prescriptions and be enriched with the real life experiences of ordinary people living in the communities.
2. Defining the adaptation measures (including the technical details) to be implemented must involve a coordinated dialogue between communities, supported by trained technical personnel and local government technical specialists.
3. Public support for adaptation to climate change must be in line with the investment priorities of the communities themselves. Since the implementation of the Popular Participation Program, municipal investments have been identified and prioritized in community and municipal workshops in which civil society has had a direct role in decision-making. Prioritizing public investments in a community is a complex and sensitive process which depends largely on the information available to the campesinos and on the power relationships existing between them. In short, it is the result of a delicate negotiating process which can be destabilized by external intervention.
4. We recommend that the different levels of government should create opportunities at the multi-community, regional, departmental, and national levels for deciding on the prioritization and scale of adaptation measures to be undertaken. It is clear that many adaptation-related investments extend beyond the purely local community environment.
5. The state needs to take into account the fact that climate adaptation requires substantial investment in infrastructure (mainly water management) but that infrastructure investment is not by itself sufficient. Resources need to be targeted also at training, equipment, research, and organizational support. One-off, isolated investments will never succeed.
6. We also recommend that within the scope of their powers and jurisdiction the different levels of government should formulate a clear and effective normative framework to support the efforts of the communities to regulate access to grassland and forests (a key element of adaptation). The study found that communities are planning to apply the rules governing communal access to natural resources in accordance with the new realities imposed by

climate change. However, given that the grasslands and forests extend beyond community lands, additional regulations will need to be formulated by the various levels of government.

7. The central government should be required to provide more information and training to local authorities and specialists on climate change impacts and adaptation policies. Climate change is a new topic in Bolivia, and the sub-national levels of government do not yet have sufficient information to deal adequately with it.
8. The State should be called upon to implement a comprehensive information program to raise the awareness of communities throughout the country about the causes, effects, and impacts of climate change, drawing on the results of studies and research. This information would assist communities to define as accurately as possible their own adaptation strategies.
9. The State should also take into account that at local level a number of private institutions, social organizations, producer associations, etc. could be called upon to cooperate as partners with the government during the formulation of public climate adaptation policies.
10. Climate change affects everyone, but some sectors are more vulnerable than others. Given that resources for proceeding with adaptation will be limited, the State must give preferential treatment to the most vulnerable sectors which, as identified in our study, are the poorest of the poor. The study succeeded in identifying communities in the central and southern Altiplano, the inter-Andean valleys, and the Chaco as well as the riverine communities in the lowlands. Other vulnerable sectors are: (i) those surviving on rainfed agriculture and extensive livestock farming; (ii) communities located on the banks of the rivers in the lowlands; (iii) households short of male workers, comprising elderly people and single women with young children, or those with male members physically unable to work; and (iv) extremely poor families who own little land or whose land is of such poor quality that production is negligible and who generally possess no savings to offset income losses and no capital to invest in adaptation.
11. We recommend that for the above-mentioned most vulnerable sectors, the State should institute, in addition to its climate adaptation support programs, specific social protection programs designed to help the poorest families and communities to cope with the worst impacts of climate change. Thus, the Crop Insurance Program now underway should be designed in such a way that it is easily accessible to the people most vulnerable to climate change.

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